THE

CHEMICAL NEWS

AND

JOURNAL OF INDUSTRIAL SCIENCE.

WITH WHICH IS INCORPORATED THE "CHEMICAL GAZETTE,"

A Journal of Theoretical and Practical Chemistry and Physics,

IN THEIR APPLICATION TO

ENGINEERING AND MANUFACTURES.

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INDEX TO

VOLUME CXXXII. JANUARY TO JUNE, 1926.

PRICE, SEPARATELY, 6D.

PUBLISHED AT THE OFFICE, MERTON HOUSE, SALISBURY SQUARE, LONDON, E.C.4.

AND SOLD BY ALL BOOKSELLERS.

LONDON
PRINTED BY REA, WALKER & INCHBOULD, LTD.
224, Blackfriars Road, London, S.E. 1.

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THE CHEMICAL NEWS,
VOL. CXXXII. No. 3429.
MERTON HOUSE, SALISBURY SQUARE,
LONDON, E.C.4.
TELEPHONES :
Administrative : Central 6521.
Printing Works : Hop 2404.

BENZOYLMETHYLGLYOXIME AS A PRECIPITANT OF PALLADOUS SALTS.

By J. HANUŠ, A. JILEK AND J. LUKAS.

(*Continued from Last Week.*)

TABLE II.

Pd. present mg.	Au present mg.	Glyoxime added c.c.	PPt. weighed mg.	Ppt. calc. mg.	Pd found mg.	Au found mg.
1.52	91.8	1	7.5	7.3	1.55	92.0
22.8	45.9	6	110.2	110.3	22.7	—
37.96	7.3	10	185.0	183.9	38.2	7.0

The results were very good. Dimethylglyoxime method in comparison with this one does not allow of directly estimating in presence of gold.

Determination of Palladium in Presence of Platinum.—Standard platinum solution was made by dissolving platinic chloride in water. Neutral or slightly acid platinic chloride gives a faint brown precipitate with benzoylmetbylgloxime. Attempts were made to find the acidity which would prevent precipitation of Pt by benzoylmethylgloxime. This does not occur when either the acidity of platinum solution is 3 c.c., HCl in 100 c.c., or 10 c.c. concentrated acid in 200 c.c. All Pd determina- of arsenic. 25 c.c. sodium arsenate solution this acidity. But when a new standard platinum chloride of another origin was used for determination, it was found that a minute amount of yellow precipitate was produced by adding benzoylmethylglyoxime, even when this acidity was maintained. It was evident that the salt contained palladium as impurity. When this yellow precipitate was filtered off and the benzoylmethylglyoxime solution added to the filtrate again, no precipitate appeared. The filtrate containing platinum was saturated with hydrogen sulphide and Pt determined. 25 c.c. of the filtrate contained .0206 g. Pt. Palladium was detected in the yellow precipitate, which was ignited and the residue dissolved in aqua regia, evaporated with HCl, taken up in a little water. The solution gave a yellow precipitate with mercuric cyanide, indicating Pd. 25 c.c. of the standard Pt solution gave .001 g. of palladium-benzoylmethylglyoxime. To obtain the correct weight of palladium, we had to allow for this. The procedure was the same as above; the acidity was 3 c.c. concentrated HCl for total volume 100 c.c. or 10 c.c. for 250 c.c. Results are given in Table III.

TABLE III.

Pd weighed mg.	Pt weighed mg.	Glyoxime added c.c.	Ppt. found mg.	Ppt. calc. mg.	Pd found mg.	Pt found mg.
1.52	20.6	1	7.4	7.3	1.53	20.6
1.52	41.2	1	6.6	7.3	1.66	—
3.04	20.6	2	14.6	14.7	3.01	—
15.2	32.9	4	74.5	73.5	15.4	33.6
1.52	41.2	1	7.7	7.3	1.59	—
1.52	41.2	1	7.6	7.3	1.57	41.6
7.59	32.9	2	33.2	36.8	7.28	—
15.2	24.7	4	73.6	73.5	15.2	25.2
30.86	8.2	8	148.1	147.0	30.6	8.6

Palladium and Remaining Elements Group Eight.—Standard solutions were prepared by dissolving commercial chlorides, except osmium, where OsO_4 was used. To prevent hydrolysis of the chlorides ,a little HCl was added. Solutions of these chlorides are mostly dark, and become lighter on adding acids or alcoholic benzoylmethylglyoxime. This occurs with the chlorides Ir and Ru, but no change takes place with $RhCl_3$. Rhodium salts are partly adsorbed by the palladium benzoylmethylglyoxime precipitate. The above procedure was again followed for OsO_4, the volume was 100 c.c., with 1 c.c. HCl. .2096 g. OsO_4 was dissolved in 100 c.c. water. Experiments were carried out with 10 c.c. containing .02096 g. OsO_4 and 40 c.c. (.08387 g. OsO_4); 1 c.c. 2 per cent. alcoholic benzomethylglyoxime was taken for the precipitation.

Pd weighed mg.	Ppt. found mg.	Ppt. calc. mg.	Pd found mg.
1.52	7.7	7.3	1.58
1.52	7.6	7.3	1.57

For the other elements of group eight, the solutions were prepared by dissolving their chlorides in water. Thus about .57 g. $IrCl_4$, .4 g. $RuCl_3$, and .4 g. of $RhCl_3$ were dissolved with 20 c.c. HCl in water and made up to 250 c.c. Their strength was found after precipitating palladium by evaporating the filtrate with sodium carbonate, igniting the residue, and extracting the black substance with water. The residue washed with dilute HCl and water, was calcined and reduced in a porcelain crucible in hydrogen, and cooled in carbon dioxide. The pure metal obtained was finally weighed. 25 c.c. of the above solutions gave .0204 g. Ir; .0192 g. Rh; and .0174 g. Ru respectively. The precipitant added varied between 1-6 c.c.

The colour of the precipitates was yellow, except rhodium, which had a greenish tint. The palladium was determined as follows :— 5 c.c. of the Rh. Ru, Ir solutions were added to 10 c.c. of the standard Pd solution, containing .0152 g. Pd. Found .0766 g. precipitate, calc. .0735; the weight of the precipitate multiplied by .2064 gave Pd .0158 g.

Separation of Palladium from Arsenic, Antimony and Tin.—Attempts were made to determine Pd by this method in the presence of elements As, Sb, and Sn. Antimony and tin chlorides need much acid to keep them in solution; As, Sb, and Sn solutions are not precipitated by benzoylmethylglyoxime. No difficulties were observed in determining Pd in the presence of arsenic. 25 c.c. sodium arsenate solution (Na_3AsO_4) and 1 c.c. of the Pd solution (.00152 g. Pd) were mixed, diluted to 100 c.c., acidified with 1 c.c. HCl, boiled, precipitated with 1 c.c. of the precipitant and treated as described above. The precipitate weighed .0074 g. (calc. .00735 g.). This, multiplied by .2064 gave .00153 g. Pd, instead of .00152 g. For Sb ,excess HCl is needed to prevent hydrolysis, but can be replaced by tartaric acid. .5 g. tartaric acid was added to 25 c.c. of antimony solution containing .2 g. $SbCl_3$ and 4 c.c. HCl, mixed with 1 c.c. of the Pd solution (.00152 g. Pd.), diluted to 100 c.c., boiled and precipitated with 1 c.c. of the precipitant as above. .00769 precipitate resulted

TABLE IV.

Pd weighed mg.	Solution of $IrCl_4$ added c.c.	Ppt. found mg.	Ppt. calc. mg.	Pd found mg.	Difference of Pd mg.	Ir found mg.
1.52	25	7.6	7.3	1.57	+ .05	20.4
1.52	15	7.2	7.3	1.49	- .028	—
15.2	15	76.0	73.5	15.7	+ .5	—
22.8	1	113.6	110.3	23.4	+ .6	—
	$RhCl_3$ c.c.					Rh found mg.
1.52	25	8.3	7.3	1.71	+ .19	19.0
15.2	15	75.3	73.5	15.5	+ .3	11.0
22.8	1	113.4	110.3	23.4	+ .6	.8
	$RuCl_3$ c.c.					Ru found mg.
1.52	25	7.5	7.3	1.55	+ .03	17.2
15.2	15	76.8	73.5	15.8	+ .4	11.2

instead of .00735 g; multiplied by .2064, this gave .001579 Pd instead of .00152 g. If tin is present tartaric acid does not completely prevent hydrolysis. Tin solutions were thus made more acid with HCl, and precipitated with benzoylmethylglyoxime. A procedure was worked out when all three were present. Thus, 25 c.c. each sodium arsenate solution, $SbCl_3$ and $SnCl_4$ were added to 1 c.c. of the Pd solution (.00152 g.) and made up to 250 c.c. with water and 15 c.c. of conc. HCl, boiled and precipitated. After standing 24 hours, a yellow precipitate appeared. .0082 g., instead of .00735 g. containing .00169 Pd instead of .00152 g., showing a small adsorption. With a larger amount of Pd (.0076 g.) and the same acidity and the same amounts of other salts (As, Sb, Sn) as above, the precipitate weighed .04 g. instead of .037 g.; .04 g., multiplied by .2064, gave the weight .0082 g. instead of .0076 g. Pd. No difficulties are met in determining Pd in the presence of Mo, W and V by this method. Although molybdates and tungstates, on acidifying, produced insoluble molybdenic or tungstanic acid, addition of phosphoric acid is needed to keep them in solution. Separation of Pd from Mo, W and V present as sodium salts, was carried out as follows :—.25 c.c. each of molybdate (.29 g. of Na_2MoO_4) and tungstate (.2 g. Na_2WO_4) were mixed with 1 c.c. of the Pd solution, .5 g. KH_2PO_4 was added with 1 c.c. HCl, made up to 100 c.c. and precipitated with benzoylmethylgloxime as usual. .0075 g. precipitate were obtained instead of .00735; (.00155 g. Pd instead of .00152 g.). When 1 c.c. of the Pd solution was mixed with 25 c.c. sodium vanadate and treated as above, the precipitate weighed .0075 g. corresponding to .00155 Pd. For the mixture of each 25 c.c. of solution molybdate, vanadate and tungstate, with 1 c.c. of Pd solution by adding 0.5 g. KH_2PO_4 precipitate weighed .0076 g. corresponding .00157 g. Pd. When the amount of Pd was 5 c.c. of Pd solution and mixed with all above-mentioned solutions, the precipitate weighed .0376 instead calc. .0368, .0078 g. Pd instead .0076 g.

Palladium and Lead, Silver, Mercury, Copper, Cadmium and Bismuth.—Since silver, monovalent mercury and lead are precipitated with hydrochloric acid the separation of palladium from these elements by benzoylmethylglyoxime method has not been considered. Therefore attention was only devoted to Cd, Bi, Hg, and Cu. Their solutions were made by dissolving 2 g. of their chlorides in each case; only in the case of $HgCl_2$, 1.5 c.c. HCl was added before making up to 250 c.c. The procedure was the same as given before. The produced precipitates were filtered off after standing 24 hours. Results are given in Table V.

Pd weighed mg.	Ppt. found mg.	Ppt. calc. mg.	Pd. found mg.
1.52	7.3	7.35	1.51
3.04	14.6	14.7	3.0
7.60	37,4	36.8	7.7

The added precipitant varied between 1-4 c.c.

Palladium and Nickel, Cobalt, Zinc, Uranium, Iron, Chromium and Manganese.—As mentioned before, manganese and nickel salts in alkaline solution give, with benzoylmethylglyoxime, a feeble precipitate, but no precipitation takes place, when solutions are acid. To prevent contamination of nickel, cobalt and manganese salts, it was necessary to precipitate in solution containing 15 c.c. HCl in 250 c.c. Standard solution of Ni, Co, Zn, U, Fe, Cr, Mn were made by dissolving 2 g. corresponding chlorides in 250 c.c. in each case. The precipitation was carried out in presence of 5 c.c. of the solutions. The precipitates were filtered off after standing 24 hours.

Results are given in Table VI.

TABLE VI.

Pd weighed mg.	Ppt. found mg.	Ppt. calc. mg.	Pd found mg.
1.52	7.4	7.35	1.53
7.60	37.8	36.8	7.8

SUMMARY.

In benzoylmethylglyoxime, a new specific reagent was found for detection and determination of palladium in acid solution (HCl). This precipitant allows of separation and determination of palladium from Pt, Ir, Rh, Os, Au, Cu, Bi, Cd, Hg, As, Sb, Sn, Mo, W, V, Fe, Ni, Co, Zn, Cr, Mn, and U, when solntion contains a sufficient amount of HCl. Palladium benzoylmethylglyoxime is a yellow substance soluble readily in ammonia, insoluble in water and in dilute hydrochloric acid. Its empirical formula is $C_{20}H_{18}N_4O_8Pd$. The procedure is as follows :—100-250 c.c. of neutral or slightly acidified solution (1 c.c.

HCl to 100 c.c.) or more strongly acidified (6 c.c. HCl to 100 c.c.), if platinum or elements platinum group are present, or tin, cobalt, nickel and manganese, or in the presence of antimony with tartaric acid acidified, or if molybdenum, tungsten and vanadium are present, addition of potassiumphosphate (KH_2PO_4) is necessary, heat to boiling and precipitate with 2 per cent. alcoholic benzoylmethylglyoxime in excess of 40 per cent. (referred to palladium), boil a few minutes and let stand 12-24 hours. Filter off through filter or porous porcelain crucible, wash with 200 c.c. water containing 6 c.c. HCl, then with water until no reaction with silver ions takes place, and dry at 100-5° C. to constant weight. Multiply the weight of the precipitate by .2064 to obtain the weight of palladium.

The Institute of Analytical and Food Chemistry of the Czech Technical High School, Prague.

THE ELECTROLYTIC DEPOSITION OF NICKEL.

By Robert Saxon, B.Sc.

In the electrolysis of nickel sulphate as with iron or copper sulphate, sulphuric acid is produced in sufficient strength to warrant the suggestion of electrolysis as a means of making it. The admixture of an equivalent weight of the sulphate of a more electro-positive metal increases the speed and yield of the deposit. A saturated solution of nickel sulphate (40 parts per 100 ccs.), is mixed with a saturated solution of potassium sulphate (10 parts per 100 cc., not equimolar) after five hours' running with the " lighting " current passing through three lamps as resistance, gives a 21% solution of sulphuric acid, an abundant deposit of nickel hydrate followed by a deposit of the metal.

As a means of making hydrogen, this is suggested as a side line to the nickel deposition. When, however, an " idle electrode " is brought into play, the evolution of hydrogen is greatly increased, and incidentally the deposition of nickel. By " idle electrode " is meant one between the others unattached to the current wire. It takes the place of two electrodes presenting a negative side to the anode, and a positiev charge to the cathode. The first metal to be experimented with was zinc.

When a sheet of zinc is immersed in the electrolyte between the electrodes, rapid evolution of gas from these results. If the zinc touches the anode, it forms part of the latter, but if moved towards the middle of the cell, ebullition increases from the electrodes. A magnesium plate acts more efficiently than zinc, both more so than iron, and the latter more than nickel, which last has little effect. Copper has practically none. It would appear that the idle electrode succeeds best if of a metal highly placed on the electromotive list. Such passes into solution as sulphate, and the vigour of the reaction is due to the sulphuric acid being removed, which would otherwise stand in the way of the ionic dissociation of the nickel or other sulphate. A convenient way of representing this ionic dissociation is here suggested thus :—

(a) H_2) H_2 : $(OH)_2$: Ni : SO_4(SO_3/O
(b) SO_3/HOH - H_2SO_4
(c) Ni) Ni : SO_4 : H_2 : $(OH)_2$(HOH/O

the sign : separating the electrified ions and anions,) and (the cathode respectively. / represents the plus sign usually employed. H_2 : $(OH)_2$ or H : OH means the elements of water ionised. Beyond the electrodes ordinary water is HOH.

DRIVING ROPES.

The Valuable Properties of Hemp in This Connection.

By A Well-Known Engineer.

Rope driving is, of course, a very old-established method of transmitting power, especially in the case of long centre to centre distances, and when drives to different shafts or floors are required from the same pulley or flywheel. Incidentally, also, the chemical industry does not as a rule make sufficient use of this method.

Most ropes used are of the round cotton variety, with 3 strands, but strong claims now being made for the superiority of square section hemp ropes are interesting both from the scientific point of view as well as that of application in chemical works and similar establishments.

Hemp is much superior to cotton in that it will stand heat, wet, dust, acids, and other deleterious factors, including the combined action of sunlight and sea-water —a very severe test—in a much superior manner, presumably because of the lignitic or ligno-cellulose composition of the fibre

as against the pure cellulose of the cotton, although the exact reason is not very clear, as many ligno celluloses are easily deteriorated. The valuable properties of hemp in this connection have been known for thousands of years and its use for ropes in marine work is universal, while further, hemp has the advantage over cotton that it is a much stronger fibre generally with greatly superior tensile strength.

The chief reason why hemp has not been used more extensively for driving ropes is that when a round rope is running, the action on each individual strand as it goes round the pulley is that of bending to and fro to a very considerable extent. The softer cotton fibre stands this action better so that it has been preferred to the harder and much more resistant hemp when made up in the round form of, say, 3 strands. But there is no need for ropes to be made in this way, and when the hemp rope is plaited with 8 strands, 4 left hand, and 4 right hand, so as to give a square instead of a round section, on the lines carried out by Messrs. Sutcliffe Bros., and Bryce, Ltd., of Hyde, near Manchester, the action is quite different, and the more numerous strands do not so much bend as slide to and fro over one another. Under these conditions, hemp can be employed without difficulty, because being much harder than cotton it stands the rubbing friction without any difficulty and, under the additional influence of grease, the strands form an almost "metal to metal" joint with one another. In this way it is claimed the superior qualities of hemp as a fibre are allowed every oportunity, and such ropes are stated to possess, as compared with a round cotton rope, much increased efficiency of power transmission, a life of many years without splicing, greater tensile strength, ability to run at higher speeds, even as much at 10,000 feet per minute, and take difficult drives and small pulleys, as well as the superior resistance already mentioned to damp, heat, dust, and acid, of particular importance for the chemical and allied industries.

To take one point only, that of pulley sizes, a square section hemp rope will run with only 18 times the diameter of the rope, with 12 in an emergency, whereas for cotton ropes the figure is 30-50 diameters, an important matter in connection with electric driving.

Finally, an interesting feature of the square hemp rope is that it is put on the pulleys under a tension approximately equal to the actual driving conditions, so that there is little sagging and slipping, as the ropes do not stretch any further, a much more scientific practice.

ELECTRICAL PORCELAIN KILNS DESCRIBED.

Mr. F. A. J. Fitzgerald, of the Fitzgerald Laboratories, recently addressed the regular monthly joint meeting of the Toronto Section, Society of Chemical Industry and Toronto Branch, Canadian Institute of Chemistry, held in the Mining Building, University of Toronto.

The subject of Mr. Fitzgerald's address was "Latest Developments in the Construction of Electrical Porcelain Kilns."

In general, this new type of kiln is constructed with outside walls of refractory brick, lined with carborundum brick, but the chief problem met and finally overcome was the construction of a suitable carbon resistor in which the heat was generated from the electric current. At first a granular carbon resistor was used, but this was not successful, and finally a resistor comprised of a series of carbon plates was evolved.

The feature of this resistor is that the plates are so placed as to touch each other only at a relatively small section of their sides, in this way greatly increasing the resistance, and thus generating the necessary amount of heat. The resistor is placed at the top of the heat chamber proper and the ware to be fired enters and leaves the kiln on cars.

It was shown that such articles as porcelain spark plugs and glazed ware could be fired at the same time. The three essential factors in firing—temperatnre, time and the reduction of the atmosphere at the proper interval—were more ably and easily controlled in the electric kiln than in the ordinary oil or gas-fired periodic kiln.

In the discussion that followed, many interesting points were brought out. In reply to a query by Mr. J. H. Mason, Mr. Fitzgerald stated that the net efficiency heat) of the electric kiln was 15% compared to 2% in the periodic kiln. The cost of operation would depend on the basic cost of the energy at point of manufacture. There was a great difference in such cost—for instance, in New York City the cost for electric power was 9/10 cent. per K.W.

hour, whereas at Niagara Falls, it was 3/10 cent. In general it could be said that the cost of operation was equally as low as oil-fired kilns, but of course the great advantage in favour of the electric kiln was the fact of simplicity and accuracy in operation and control.

Mr. Kelleher compared the operation of the electric with the ordinary kiln. In the latter, two or two and a half days were taken up setting the ware in the 1,500 to 2,000 saggers often used in such kilns. Then it was fired for three days, then a day or two was wasted waiting for the kiln to cool down from 1,500° to 150° F., so that the saggers could be handled, in which handling many saggers were broken. All this often required twenty men.

In the electric kiln, on the other hand, two men only were necessary—one to load the cars and one to unload, or taking 24-hour operation, six men as compared with 20.—*Canadian Chemistry and Metallurgy.*

THE EQUILIBRIUM IN THE SYSTEM CONSISTING OF POTASSIUM SULPHATE, POTASSIUM NITRATE AND WATER AT 25.0°.

By Ryohei Inouye.

H. Euler determined the composition of solutions saturated both with potassium sulphate and potassium nitrate at 15°, 20° and 25°. A Massink studied the equilibrium of this ternary system at 35°, and found that only KNO_3 and K_2SO_4 exist as solid phases.

Now, the equilibrium of this system at 25° was studied, as knowledge of it became necessary in the course of another investigation, and the results are given in this article.

The two potassium salts were of the Pharm Jp. They were thrice recrystallised. A mixture of the two salts in a certain proportion was put in an Erlenmeyer flask of about 30 c.c. capacity, some ordinary distilled water was added, and the flask, well stoppered, was made to rotate in a thermostat at 25° for a few days. When equilibrium was attained, the solution was drawn off with a pipette through purified cotton, and the residue was centrifuged promptly to remove as much as possible of the mother liquor. They were analysed separately.

The potassium was determined as potassium sulphate. The sulphate radical was determined as barium sulphate, after the removal of nitric acid. The nitrate radical and water were found by calculation.

(Memoirs, College of Chemistry, Tokio Univeristy.)

INVESTIGATIONS ON THE PLATINUM METALS.—VII. ARC SPECTRA OF THE PLATINUM METALS.

By W. F. Meggers.

(*Bureau of Standards, Washington D.C., U.S.A.*)

In other papers of this series mention has been made of the use of the spectrograph to follow the progress of chemical separation of the platinum metals. When materials aproximating spectroscopic purity were prepared in this bureau an investigation of the arc spectra was undertaken primarily for the purpose of securing data in the red and adjacent infra-red regions where no data on the emission spectra of the platinum metals existed. Specially sensitised plates were employed to record the spectra with large diffraction gratings, and many hundreds of new lines were measured in the yellow, orange, red, and infra-red regions. Comparison with previous observations in the regions common to the old and to the new measurements showed that the former were incomplete. This led to an extension of the latter to shorter waves, thus including almost all of the visible spectrum, and made it possible to carry out a more extensive comparison of the spectroscopic purity of the materials used by the different observers. New values of wave lengths and estimated relative intensities are given in six tables as follows: 1,260 lines for ruthenium (4498.16 to 8867.84A), 572 lines for rhodium (4503.80 to 8615.23A), 172 lines for palladium (4497.66 to 9234.02A), 942 lines for osmium (4500.74 to 8644.8A), 605 lines for iridium (4500.97 to 8426.11A), and 239 lines for platinum (4498.75 to 8762.48A). The wave lengths were measured relative to the secondary standards in the spectrum of the iron arc, and each value is, in general, the mean of from 2 to 10 determinations. The probable error of these values rarely exceeds one one-hundredth of an Angstrom unit. Six short tables giving lines ascribed to platinum metals by other observers, but not visible on the new spectrograms are subjoined to the major tables, and most of these lines are identified as impurities in the

materials at the disposal of the earlier observers. Intercomparison of the results of the new measurements indicate that the metals used in this investigation were exceptionally pure, since even the most intense lines characteristic of each particular element rarely, if ever, appeared in the spectra of the other elements.

As has been stated in Paper II. of this series, the Bureau of Standards several years ago began a comprehensive investigation involving the purification of all metals of the platinum group and critical studies of analytical separation, the melting and mechanical working of the pure metals and their alloys, the study of selected alloys with respect to their suitability for platinum ware, and the determination of physical properties of both metals and alloys. In the paper just cited and in other papers of the series, mention is made of the nse of the spectrograph to control the process of purification of these metals. With this first phase of the investigation well advanced, it has been possible to begin the last phase mentioned, viz., determination of the physical properties of the pure metals. The electric arc emission spectra of the six metals—ruthenium, rhodium, palladium, osmium, iridium, and platinum—have been made the object of special study in the visible and adjacent infra-red spectral regions, and the purpose of this paper is to present the data thus obtained.

These data are similar to others published in a series of papers dealing with arc spectra in the yellow, red, and infra-red regions with which the spectroscopy section of this bureau has been more or less concerned for the past 10 years. The initial object of this programme was to extend the spectroscopic data for the longer waves and thus contribute to a complete description of the standard arc spectra of all the chemical elements. The production of the platinum metals in a state of high purity by the chemists of this burean has been very favourable toward forwarding this part of the programme. A study was completed for wave lengths greater than 5500A more than a year ago, but when the tables were compiled it appeared, from those portions which overlapped the earlier observations, very desirable to extend the new measurements to the violet. This was with the thought that it would permit a more satisfactory comparison of the materials and results of the different observers. The comparisons, when made, indicated that it might further be advisable to re-examine the spectra of these pure metals in the ultra-violet. Necessity for the postponement of this additional work has led to the decision to publish, without further delay, the results thus far obtained for wave lengths greater than 4500A.

Only three earlier investigations on the arc spectra of the platinum metals permit of a comparison of values with those given here. The first was by Professor Kayser, who, in 1896, carefully measured the spectra throughout the range of wave lengths from ultra-violet to yellow. The second was by Eder and Valenta, who, in 1910, extended Kayser's tables to the orange and red, but recorded only the stronger lines. The third was by Exner and Haschek, who, in 1911, published their extensive observations on The Spectra of Elements at Normal Pressure. In this case, too, the data are incomplete, especially for the longer waves in the visible spectrum. In all three cases the wave-length values were based on the Rowland scale. With one exception, referred to below in the discussion on platinum, up to the present time no values for the arc spectra of the platinum metals have been determined relative to the new system of international standards adopted since 1910.

Apparatus and Methods.

Two different concave diffraction gratings each 640 cm. radius were used for obtaining the spectrograms. These were interchangeable in the mounting which has been described in another paper. For the region to the red of 6000A an Anderson grating of 7,500 lines per inch giving a scale of 10.4A per mm., was used because it gives an exceptionally bright spectrum, so desirable for speed in the infra-red. The final results for wave lengths from 4500 to 6000A are compiled from spectrograms made with a Rowland grating with 20,000 lines per inch which gave a dispersion of 3.75A per mm. Some of these larger scale spectrograms extended beyond 7000A; for the longer waves the Rowland grating was considerably slower than the Anderson grating.

The spectograms were made on Schleussner ultra-rapid plates 40 cm. long by 6 cm. wide. These were about 1 mm. thick and could, therefore, be bent to fit the focal curve of the grating and thus afford an equally sharp focus over the entire plate.

For the region 4500 to 6000A the plates were stained with pinaverdol, from 5500 to 7500A pinacynol was used, and dicyanin served from 6500A into the infra-red. The exposures averaged about 5 minutes in the blue, green, and yellow; 15 to 20 minutes for the orange and red; and 1 hour for the infra-red. More lines would probably have been found in the infra-red if the exposures had been continued for two or more hours, but it was considered that the possible additions to wave-length data would not justify the consumption of large amounts of these costly pure metals.

Observers of arc spectra of the six elements in this group have been forced to use metal sponge or salts on electrodes of carbon or copper, except that platinum and palladium have generally been available in the form of ingots for use as arc electrodes. Thus, Kayser used salts of ruthenium, rhodium, osmium, and iridium on carbon electrodes in which he recognised the following impurities: Calcium, aluminium, sodium, manganese, chromium, nickel, titanium, etc. Eder and Valenta and Exner and Haschek used carbon electrodes in most of their exposures, necessitating the examination of each spectrogram for the particular lines which represented electrode materials or impurities. The use of carbon electrodes for spectra of the platinum metals is somewhat unsatisfactory, since, in addition to numerous impurities usually found even in the best carbon, it is very difficult, especially with high boiling-point metals, to suppress the complex spectra representing carbon compounds.

In the present investigations ingots of pure platinum and palladium were used as arc electrodes. The remaining metals were in the form of sponge, and attempts were first made to obtain suitable spectragrams of these with Acheson graphite, which has been found to be much purer than commercial carbon. The spectra due to carbon and its compounds, however, were usually strong enough to mask most of the others. This method of observing was, therefore, discarded and all spectrograms which have been measured here were made with electrodes of copper or silver. These metals are especially suitable for the investigation of the longer-wave spectra since they contain relatively few lines, and the characteristic colours of the arcs indicate whether the light is coming primarily from the electrode material or from the test samples placed upon them. The arc flames of both copper and silver have a distinct green colour, consisting in the case of copper mainly of three deep green emission lines (5105.58, 5153.26, 5218.20A) and two yellow-green lines (5700.25, 5782.16A); while for silver the colour is imparted mainly by two intense green lines (5209.08, 5465.49A). Elements whose spectra are characterised by a large number of lines none of which are overwhelming in intensity generally give a bluish-white colour to the burning arc. Such is the case, for example, with ruthenium, rhodium, osmium, and iridium. When these metals are properly burned on copper or silver electrodes they change the arc colour from green to white, and it is possible thus to photograph their spectra with almost complete suppression of all but the strongest lines from the electrode materials. The arcs were operated with a potential of 240 volts and direct current of 5 to 6 amperes. A record of the weights of the electrodes and the exposure times for palladium and platinum showed that these metals were volatilised in the arc at the rate of about 1 g. per hour.

The difficulty of chemically separating the six metals of the platinum group from each other has been a great handicap to spectroscopists who have attempted to describe the spectra with more or less completeness. It has been necessary heretofore to use impure materials and to intercompare the wave lengths and relative intensities of all lines in different spectrograms so as to identify the contaminations and properly assign each line to the element which is characterises. Even when applied with great patience and rare judgment, this procedure is objectionable, especially in dealing with such complex spectra as those of the platinum metals, and it may account in large part for the unsatisfactory descriptions which have been given to these spectra. Kayser states that he and Runge began extensive investigations of these spectra in 1894, but because of the impure state of the metal, all of their spectrograms were discarded. Kayser repeated the investigation in 1896 with materials of somewhat higher purity prepared by Bettendor: for atomic-weight determinations. Even these were found spectrographically to be impure, and Kayser admits, for instance, that in striking from his list of Ir lines, most of the coincidences with strong Ru lines some true Ir lines may have been removed. Eder and Valenta do

not mention the source of their materials, but it is unlikely that their platinum metals were much purer than those at Kayser's disposal. They suspected their iridium of containing rutheuinm and state that rhodium lines had to be eliminated from their measures of the ruthenium spectrum. The platinum metals which Exner aud Haschek used were furnished by Heräns. In each case their spectra showed that they were dealing with impure materials, and it was necessary to subtract the lines of from 3 to 12 impurities from each of the spectrum tables. The impurities originating in the platinum metals and electrode materials used by these early observers will be referred to in more detail in connection with the results of the present investigation. The difficulty is stressed at this point for the purpose of emphasising the fact that it has been apparently eliminated. That the platinum metals used in this examination are very pure, indeed, is evidenced by the wave-length tables given below. In the compiliation of these tables only the lines due to copper or silver electrodes or their impurities and the atmospheric lines which are common to all open-air arc spectra have been removed; all the remaining lines which were measurable on the spectrograms are given. Intercomparison of these tables shows that the strongest lines of any one spectrum are almost without exception, positively absent from all the others. To be sure, coincidences of wave lengths may occur, and some of these which involve strong lines have been marked. It is probable, however, that most of these purely fortuitous and cannot be interpreted as mixed spectra.

Spectra.

The spectrograms were measured on a large engine whose smallest scale division is 0.001 mm., corresponding to 0.0104A on photographs made with the Anderson grating and to 0.0038A on plates exposed with the Rowland grating. All of the wave-length measurements are based on the internationally adopted values of secondary and tertiary standards in the spectrum of the iron arc. Each wave length given in the following tables is, in general, the mean of from 2 to 10 determinations. Lines between 4500 and 7000A with intensities greater than 9 or 10 were accompanied by ghosts in the spectrograms made with the Rowland grating; additional values for the wave lengths of the parent lines were derived from measurements on these ghosts. In general, the probable error for lines of intensity 2 or more rarely exceeds one one-hundredth of an Angstrom unit. About 5 per cent. of the lines of intensity 1 and half of those marked "0" were observed only once; the wave-length errors in these cases may be somewhat larger.

It is generally admitted that one of the most unsatisfactory features of spectrum tables is the estimation of relative intensities of the different lines. There does not appear to be any simple, reliable method for measuring the energy in each emission line, and the general practice for nearly half a century has, therefore, been to assign numbers to the lines, such numbers representing arbitrary intensity gradations. Most frequently spectroscopists have assigned intensity 1 to the weakest lines and 10 to the strongest. This is the scale which has heretofore been in use in this laboratory. It is also the range of estimates by Eder and Valenta and by Kayser, except that the last named has represented the very weak lines of the platinum metals by 0. Exner and Haschek have employed a somewhat wider range according to which the stronger lines are represented by tens or even hundreds of units.

The structures of a considerable number of complex spectra have recently found interpretation in the discovery of related groups of lines called multiplets, and the intensities of lines in each multiplet are apparently governed by definite rules. This development emphasises the importance of correct values for relative intensities and indicates that the actual range in most spectra should be greater than 1 to 10. In the present description of the arc spectra of the platinum metals an attempt has been made to use a new scale of intensities which may be defined as follows: Lines which were easily measurable under the microscope were called intensity 1, and whenever a line appeared in the Rowland-grating spectrograms to have first order ghosts of intensity 1 the intensity of the parent line was arbitrarily assigned the number 10. Lines of intensity 0 are difficult to make settings on, and the ghosts of lines whose intensities are 8 or 9 are assigned to this class. The relative values assigned to all other lines resulted from interpolated estimates, the values for very strong lines being based on the estimated intensities of their ghosts; for example, if the number 5 was

assigned to a ghost, the intensity of the parent line was marked 50. It appears that such a procedure may be of considerable value in making quantitative distinctions if based upon a determination of the actual ratio between the energies of parent lines and ghosts.

Trade and General Notes.

THE EFFICIENCY OF THE HEART AND ITS MEASUREMENT.

The Lancet for December 26, 1925, publishes the second of two important lectures delivered at the University of London by Professor Youdel Henderson (Professor of Applied Physiology, Yale University).

The conclusions arrived at by Professor Henderson are :—

" Now at last we know with precision the stroke volume of the heart and the volume of the circulation. We know the range of variation in normal men and women, and in general in all mammals. On the basis of such data the activity of the heart and the volume of the blood-stream are here correlated quantitatively with the size, vigour, and gaseous exchange of men and animals during rest and muscular work. The principles underlying this correlation are formulated. The volume of the blood-stream through the lungs is determined from the rate of absorption of ethyl iodine vapour. This method affords an efficient and clinically practicable means of measuring the circulation, not only in normal persons, both those of athletic and those of sedentary habit, but also in patients with moderate cardiac impairment.

Thus the problem of measuring the volume of the blood-stream—the problem which was in effect defined by William Harvey when he discovered the circulation nearly 300 years ago—is now solved."

The Lancet gives an interesting article on the lectures.

JAPANESE DYESTUFF LAW.

The British Ambassador at Tokio reports that the following ordinances relating to Law No. 29 of 28 March, 1925, for the encouragement of the manufacture of dyes in Japan, were pubished in the *Official Gazette* of 13 October :—(1) Imperial Ordinance No. 301 providing that Law No. 29 shall take effect as from 15 October, 1925, and (2) Imperial Ordinance No. 302 specifying the varieties of dyes in respect of which subsidies are to be paid. The Britsh Ambassador has forwarded a translation of the Regulations issued in connection with the enforcement of Law No. 29, which can be consulted by British firms interested on application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

MAN AND HIS DUMB ANIMAL FRIENDS.

One of the activities of the Metropolitan Insurance Company of New York in its great welfare programme is its " Tower Health Talks," broadcast by leading doctors. A recent talk by Dr. Ingo Galdston, M.D., dealt with the untold benefit to humanity resulting from experiments on animals by doctors and other scientific men. Dr. Galdston opens his talk with the experiments of John Hunter, and gives many instances of how animal experiments have enabled doctors to vanquish disease. The following are typical pars of the talk :

" The child born with a deficient thryoid, which, if untreated, soon appears idiotic, with a pot belly, coarse hair and protruding tongue, to-day can be made normal by a treatment based on the facts gathered through experiments made upon the thyroids of animals.

The conquest of anthrax, or malignant pustule, or, as it is sometimes known, wool sorter's disease, the conquest of tuberculasis, diphtheria, tetanus or lockjaw, rabies or hydrophobia, cholera, the plague, typhoid fever, and malaria, was possible mainly because of man's experiments upon animals."

A LIVING SALARY.

The University of London is about to appoint a principal officer to take up duties on September 1, 1926, at a salary of £2,500 per annum. Names must reach the University, South Kensington, London, S.W.7., by February 1, 1926.

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN.

21, Albemarle Street, London, W.1.

THE TRADE OF THE SAILOR.

Every old trade has a history which is wonderfully interesting because it is a human story; a record of the attempts of men to satisfy their needs and desires. There are always individuals and peoples which are at any one time striving towards greater skill and better results in some enterprise or industry; using all new knowledge for that purpose. So trades grow, sometimes slowly, sometimes quickly; and the histories of trades affect profoundly the histories of peoples.

An ontstanding featnre in the history of the sailor's trade is the change when he first made long voyages without sight of the land; and it became necessary to increase his knowledge of the heavens so that he might find out where he was. The stars had always served to guide travellers, bnt the old methods were no longer sufficient. In very recent years new and striking methods have been found to help in solving the old problem.—*Sir William Bragg, F.R.S.*

THE TRADE OF THE SMITH.

The smith's trade has slowly developed with a gradually increasing knowledge of metals and their compounds. Except in one or two instances, there is not much use for a pure metal; it is the alloy, or the compound like steel that has qualities of value. As new alloys have been made and tried, or new varieties of steel, opportunities have been found to satisfy more and more of the innumerable demands of men for tools and constructions of various designs and for various purposes.—*Sir William Bragg, F.R.S.*

FARADAY SOCIETY.

The Formation of Polar Compounds by Photo-Chemical Reactions, by W. Albert Noyes, Jr., D-ès-Sc. (Assistant Professor of Chemistry, the University of Chicago).

Paper read on October 1, 1925.

A polar compound is formed when an electropositive element reacts with an electronegative radical or element. Let us consider any hypothetical reaction $M + N = MN$ in which M is the electropositive constituent and N the electronegative constituent. This reaction may conceivably take place in steps: $M = M^+ +$ electron; $N +$ electron $= N^-$; $M^+ + N^- = MN$. The first of these reactions involves the absorption of energy. In the case of a monatomic vapour this energy could be calculated from the ionisation potential. For solid or liquid metals this energy could be calculated from the wave-length of the photoelectric threshold. The second step leads to the emission of radiation, and therefore the evolution of energy, and the third step should also take place with evolution of energy. The only step in the reaction which does not tend to take place spontaneously is the first. It is a well-known fact that light of the proper wave-length will cause emission of electrons from monatomic vapours and from solid metals. It is my purpose to discuss certain experiments which seem to indicate clearly that some photochemical reactions may take place according to the mechanism postulated.

About two years ago one of my students, Mr. H. R. Moore, investigated the reactions between oxygen and mercury and between nitrogen dioxide and mercury. The first of these reactions leads directly to the formation of mercuric oxide. The course of the second reaction is somewhat more uncertain, but would seem to be:—

$$4Hg + 2NO_2 = 4HgO + N_2$$

It is immaterial whether or not the final products of the reaction are given by this equation. The first step in the reaction would probaby be the formation of mercurous or mercuric nitrite highly polar compounds. The original purpose in this investigation was to show that the mercury surface was activated after emission of electrons by the photoelectric effect. At the time our paper was published we were rather inclined to the view that this is the case, although we advanced the alternative explanation that the gas was activated in some way during our experiments. It is my intention to discuss these results more fully than has hitherto been done, as it seems to me that they elucidate the mechanism of one type of photochemical action

The rate of reaction between mercury and nitrogen dioxide is normally quite rapid. Since the mercury surface used was small, this rate of reaction could not be

satisfactorily followed by the pressure decrease. However, it was possible to obtain a fairly quantitative measure of the reaction rate by observing the film of mercury. A coating is formed on it which gradually increases in thickness until wrinkles can be seen on the surface. This point at which the film is thick enough to be easily visible is very definite and the rate of the reaction is very nearly inversely proportional to the time of formation of the film up to this point. This time of formation was a function of the pressure of nitrogen dioxide (for the reaction in the dark), being longer for the lower pressures as would be expected.

SOCIETY OF GLASS TECHNOLOGY.

Some Things About Glass.

The two papers read and discussed at the meeting of the Society of Glass Technology at University College, London, on Wednesday, December 16th, were both provided by the Department of Glass Technology at Sheffield. The first, entitled "The Composition of Glass Suitable for Use with Automatic Machines," by Prof. W. E. S. Turner, M.Sc., gave him an opportunity of ranging over the whole field of glass compositions which had been used, particularly for glass bottles, from the time of the Roman makers down to the present day. The introduction of the automatic machine had very much limited the range of compositions available. For example, in using a number of types of machines, the percentage of lime in the glass could not be raised safely above 10 per cent., whereas in some of the glass used on the continent and worked by hand, the percentage had considerably exceeded 20 without causing excessive difficulty. Professor Turner then went on to indicate various compositions of glass which had been employed in recent times, both in this country and in America, pointing out that the factors which decided the limits of composition were the size of thhe article, whether colourless or coloured, the method by which the machine was to be charged, that is to say, whether by suction or by gob feeding, and finally by the type of machine itself. Scientifically, the factors of importance were the viscosity of the glass, the rate at which the viscosity changed with temperature, the heat conductivity and heat radiation.

In the second paper, entitled "The Relationship between the Durability and the Chemical Composition of Glass," by Miss Dimbleby, M.Sc., and Prof. Turner, D.Sc., the account which was given by Miss Dimbleby was of work which had been proceeding at Sheffield for several years. Glasses were tested of similar type in which soda was replaced successively by lime, magnesia, alumina, titania, zirconia, barium oxide and boric oxide. In all, 70 to 80 individual glasses were prepared, and the action of the four reagents, namely, boiling water, hydrochloric acid, sodium carbonate and caustic soda solution were tested. The research probably represented theh most thorough attempt which had been made up to now to discover the relationship between the durability and the chemical composition.

The ordinary meeting at which the papers were read, was preceded by a special general meeting at which a gift of residual funds amounting to about £2,500 was accepted by the Society from the Glass Research Association. The interest on this sum is to be devoted to the writing, year by year, of a report by some eminent authority on the progress of glass technology.

FLUORSPAR AND CRYOLITE.

By Hubert W. Davis.

(*U.S.A. Bureau of Mines.*)

Fluorspar.

Fluorspar, or fluorite, is a non-metallic crystalline mineral that usually occurs in glassy transparent cubes or cleavable masses. Less commonly it is granular or banded. Fluorspar has a specific gravity of 3.2, is brittle, has a hardness of 4, and can easily be scratched by a knife. Chemically it consists of calcium and fluorine in the proportion og 51.1 to 48.9. In colour fluorspar ranges, according to purity, from a clear colourless, or slightly bluish, glass-like substance through various brilliant hues, of which purple and green are most common; much of it is white and opaque.

Fluorspar Mined and Shipped.

The shipments of fluorspar from domestic mines in 1924 amounted to 124,979 short tons, valued at $2,451,181, an increase of 3 per cent. in quantity, hut a decrease of 2 per cent. in total value as compared with 1923. The general average price per ton f.o.b. mines or shipping points for all grades in 1924 was $19.61, a decrease of

$1.07 from the average in 1923. The highest average price in 1924 was reported from Illinois and the lowest in Colorado. Kentucky and Colorado were the only States that showed an increase in shipments in 1924. The shipments of fluxing grade fluorspar to steel plants and to foundries showed an increase of about 11 per cent. in 1924, but the shipments of the higher grades of fluorspar recorded a decrease of about 28 per cent.

The exact quantity of crude fluorspar mined cannot be ascertained, because at most of the smaller mines only the cleaned material is weighed. The total quantity of merchantable fluorspar recovered by mining and milling in 1924 decreased nearly 2 per cent. from 1923.

Cryolite.

Cryolite occurs in commercial quantities and is mined only in Greenlaud, at Ivigtut. Formerly, two-thirds of the product was sold to the Pennsylvania Salt Co., and the other third weut to Copenhagen, but at present these relative proportions are reversed. Of the cryolite shipped to the United States the greater part is now used as a flux in the metalurgy of aluminium and for making opaque glass. In alumininm metallurgy in this country the mineral is being supplanted by artificial cryolite.

The imports of cryolite into the United States iu 1924, according to the Bureau of Foreign and Domestic Commerce, amounted to 6,320 long tons, valued at $320,670, or $50.74 a ton, as compared with 6,375 long tons, valued at $319,959, or $50.19 a ton, in 1923.

ARSENIC.

By V. C. Heikes and G. F. Loughlin.

(*U.S.A. Bureau of Mines.*)

Production.

The output of refined and crude white arsenic (arsenious oxide, As_2O_3), in the United States in 1924, according to producers' reporting, exceeded previous records and amounted to 20,177 short tons, of which 5,724 tons remained in stock. The total sales amounted to 14,453 tons, valued at $,655,015, or an average of 9.2 cents a ponud. The sales of crude arsenic, 92 to 96 per cent. pure, amounted to 2,183 tons, at an average of 6 cents a pound. Most of the crude product was converted into some of the crude arsenic was sold in small lots to farmers for killing grasshoppers. Manufacturers of plate glass continued to find certain makes of crude arsenic of value to the glass industry. The sales of white or refined arsenic, 99 per cent. or more pure, amounted to 12,270 tons, valued at $2,392,988, or 9.75 cents a pound. Small sales of red arsenic of domestic origin were reported from the stock made in 1922 at Index, Wash., but no metallic or elemental arsenic is known to have been produced in 1924 in the United States.

Census of Manufacture of Arsenic Compounds.

The Bureau of the Census, after the close of the year ended June 30, 1924, made a special census of calcium arsenate to determine the output for that year. The resulting statistics, although admittedly not comprehensive, were summarised by the Bureau of the Census as follows :—

There were produced during the year ended June 30, 1924, 43,625,000 pounds of calcium arsenate, an increase of 19.6 per cent. as compared with 36,481,000 pounds for the year ended June 30, 1923; 21,004,000 pounds of lead arsenate, an increase of 38.5 per cent. as compared with 15,161,000 pounds for the preceding year; and 6,092,000 pounds of Paris green, an increase of 28.4 per cent. as compared with 4,746,000 pounds for the preceding year. Based on the figures published by the United States Geological Survey in its bulletin "Arsenic in 1923," the consumption of white arsenic in the manufacture of these compounds amounted to 28,080,000 pounds, of which total 17,958,000 pounds was used in the production of calcium arsenate, 6,605,000 pounds for lead arsenate, and 3,517,000 pounds for Paris green. During the year these manufacturers purchased 32,245,000 pounds of white arsenic. The excess of the quantity purchased over the quantity consumed in the manufacture of calcium and lead arsenates and Paris green was due to consumption in the production of other arsenic compouuds, sales of arsenic as such, and probably an increase of stocks.

The figures are based upon the data for 23 establishments. Because of the failure of a number of manufacturers to report, estimates were used in the determination of the quantity of arsenic purchased, and the

these estimates being based upon the ratios which the totals of the reports received bore to the totals for the same establishments as reported to the United States Geological Survey for the calendar year 1923. During the year ended June 30, 1924, calcium arsenate was produced by 18 establishments, lead arsenate by 18 establishments, and Paris green by 8 establishments.

ARSENICAL ORES.—OUTPUT AND TREATMENT.

Active search for arsenical ore deposits was begun during 1923 in eight western States and resulted in the production in 1924 of 52,198 tons of ore, concentrate, and old arsenical speiss, containing the equivalent of 15,494 short tons of white arsenic (As_2O_3), of which about 85 per cent. was recoverable. Much of the ore mined remained in stock at roasting plants, but how much was not determined. Some of the ores mined were concentrated, the concentrate roasted, and the calcines containing gold, silver, and iron sold for smelting. Some calcines containing copper or lead in sufficient quantity to be paid for at the smelter.

WORLD'S PRODUCTION.

Judging from the quantity imported, the foreign production of white arsenic during the first half of 1924 continued at about the same rate as in 1923. In June the severe slump in the price of white arsenic caused a big decrease of imports from all countries except Canada. Both Canada and Mexico were continuous shippers; in August the latter increased its exports to the United States and in November doubled them. Producers in several countries stopped all shipments to the United States before the end of 1914. The principal foreign countries producing white arsenic are shown in an accompanying table, but the output for 1924 is not available.

FORTHCOMING EVENTS.

Jan. 1926.

Tues. 12.—Institute of Petroleum Technologists.

Wed. 13.—Institute of Chemical Engineers and Society of Chemical Industry. (L.S.)

Thur. 14.—Oil and Colour Chemists' Association.

Mon. 18.—Chemical Industry Club.

Wed. 20.—Institute of Chemistry. (L.S.)

Thur. 21.—Chemical Society.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, London, W.C.2.

Wireless Section Meeting.—Wednesday, 6 January, 1926, at 6 p.m. (Light refreshments at 5.30 p.m.) "*Frequency Variations in Thermionic Generators,*" by Lt.-Col. K. E. Edgeworth, D.S.O., M.C., Associate Member. A demonstration will be given.

On Thursday, January 7, 1926, at 6 p.m. Captain P. P. Eckersley, "The Past, *Present and Future Development of Wireless Telephony.*"

ROYAL SOCIETY OF ARTS.

John Street, Adelphi, London.

Under the Dr. Mann Trust, Professor Henry E. Armstrong, F.R.S., will present to a juvenile audience, "Alice in Wonderlond, at the Breakfast Table." He will be aided and abetted by Alice, Mad Hatter, *The Dormouse, The March Hare, Brer* Rabbit, The Cook, The Duchess, Father Christmas and Tar Baby. The play will be given in two acts, the first on Wednesday, January 6, the second on Wednesday, January 13, each day at 3 p.m. Special tickets are required for these presentations, and these have now all been issued.

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New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

31,008.—Cederberg, I. W.—Apparatus for catalytic combustion of ammonia

substances from effluent liquids. December 9th.
and oxygen mixtures. December 8th.

31,010.—Faithfull, S. E.—Process of making lactic acid and lactates. December 8th.

30,977.—Pfanhauser, W. A. F.—Production of finished articles from electrolyte iron. December 8th.

31,117.—Techno-Chemical Laboratories, Ltd.—Disposal of and recovery of

Specifications Published.

243,394.—Russell, R. — Production of alkali polysulphides containing sulphur in a colloidal form.

Abstract Published.

241,278.—Catalysts.—Technical Research Works, Ltd., and Lush, E. J., 4, Milner Street, Chelsea, London.

Catalytic agents, preparation and treatment of.—The process of the parent Specification for the activation and reactivation of the surface of metallic catalysts by electrolytic anodic-oxidation and subsequent reduction is applied to the treatment of alloys of two or more metals, e.g., a nickel-copper alloy. The products, whose surface on reduction approximates in composition to that of the unoxidised alloy, are hydrogenation of alcohols. A further modification of the process of the parent Specification consists in the reduction of the electrolytically-oxidised surface without previously removing the alkali metal salt employed as electrolyte. The product then consists of a metal together with a trace of the alkali metal salt which exercises a promoting effect when the catalyst is employed for the synthesis of ammonia or the manufacture of hydrogen. Salts of the rare alkali metals may be employed.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

SPETON.

462,940.—Chemical substances prepared for use in medicine and pharmacy.—Hermann Temmler, trading as Temmler-Werke Vereinigte Chemische Fabriken, Flugsplatz 6, Berlin-Johannisthal, Germany. December 9th, 1925.

JIX.

462,282.—Chemical substances prepared for use in medicine and pharmacy.—J. Smith, 213, Harehills Lane, Leeds. December 16th, 1925.

ROBBIALOID.

463,949.—Chemical substances used in manufactures, photography, or philosophical research and anti-corrosives.—Jenson and Nicholson, Ltd., Goswell Works, Warton Road, Stratford, London, E.15. December 16th, 1925.

SIGMARGYL.

463,608.—Chemical substances prepared for use in medicine and pharmacy.—Marcel Pomaret, 21, Rue Marbeuf, Paris, France. December 16th, 1925.

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Publisher's Announcements.

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1924	,,	128—129	,,	1 1 0 ,,		,,	0 16 0 ,,
1925	,,	130	,,	0 17 6 ,,		,,	0 13 0 ,,

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All communications should be addressed to the Manager, CHEMICAL NEWS,

THE CHEMICAL NEWS,

VOL. CXXXII. No. 3430.

MERTON HOUSE, SALISBURY SQUARE,
LONDON, E.C.4.

TELEPHONES :
Administrative : Central 6521.
Printing Works : Hop 2404.

THE RELIABILITY OF VACUUM ANALYSIS FOR SOLID METALLIC HYDRIDES.

By EDWARD JOSEPH WEEKS, Ph.D., M.Sc., A.I.C.

For some time past the author, in conjunction with Dr. Druce, has been engaged in the preparation of solid metallic hydrides. Hydrides of arsenic, antimony, bismuth and lead, have been isolated. Their formulæ have been determined by heating the hydride in vacuo, estimating the hydrogen given off by volume and the metal by weighing. Enough results have now been obtained to test the reliability of the method. For this purpose, all the analytical results obtaiued for the various hydrides have been compared with the calculated ones, and the percentage errors on the calculated results were then obtained. The mean of these deviations was then found, both for hydrogen and metal estimation.

The average error on hydrogen analysis was thus found to be ± 11%, and the average error on metal analysis ± .047%. Since the actual percentage of hydrogen in the hydride has usually been about 1%, ± 11% of this gives an error of .11%. Since the metal percentage is usually 99%, .047% of this gives .0465% error.

Now the formula of the hydride must be in one of the following series :

MH,	MH_2,	MH_3	... ...	MH_y
M_2H,	M_2H_2,	M_2H_3	... ...	M_2H_y
M_xH,	M_xH_2,	M_xH_3	... ...	M_xH_y

Now if the first series is taken, since the atomic weight of hydrogen is 1, the percentage of hydrogen increases in the series from 1 atom to 2; 2 to 3; etc., is independent of the atomic weight of the metal. For the formula to be decided, the error must be greater or less than one-half of the difference in the percentage of hydrogen in two following formulæ. Therefore, if x is the number of metal atoms, the greatest percentage error on hydrogen analysis [E] allowable is given by the equation

$$\frac{100}{2x} = E$$

But E = 11%

$$\therefore \quad \frac{100}{2x} = 11$$

$$\therefore \quad x = \frac{50}{11} = 4.54\%$$

The method of analysis is, therefore, not reliable beyond the series M_4H. Hence, all results for hydrogen can only be taken as correct on the assumption that the hydride has a formula H_xH_y where x is 4 or less.

Turning now to the metal estimation, it is obvious that account must be taken of the atomic weight of the metal, and this must be between 1 and 238 [uranium].

Let M = atomic weight of the metal.
x = number of metal atoms.
y = number of hydrogen atoms.

$$\text{Then} \quad \% \text{ of metal} = \left[\frac{xM}{xM + y}\right] 100$$

Now let 1 hydrogen atom be added.

$$\text{Then} \quad \% \text{ of metal} = \left[\frac{xM}{xM + y + 1}\right] 100$$

Difference in Hydrogen % =

$$\left[\frac{xM}{xM + y}\right] 100 - \left[\frac{xM}{xM + y + 1}\right] 100$$

Considering, as before, the error [E] allowable as not more than one-half of this, we have

$$2E = \left[\frac{xM}{xM + y} 100 - \frac{xM}{xM + y + 1} 100\right]$$

$$= 100 \left[\frac{xM}{xM + y} - \frac{xM}{xM + y + 1}\right]$$

But E = .047

$$\frac{2y \; .047}{100} = \frac{xM}{xM + y} - \frac{xM}{xM + y + 1}$$

$$\therefore .00094 = xM \left[\frac{1}{xM + y} - \frac{1}{xM + y + 1}\right]$$

$$\therefore .00094 = xM \left[\frac{xM + y + 1 - xM - y}{(xM + y)(xM + y + 1)}\right]$$

$$\therefore .00094 = xM \left[\frac{1}{[xM + y][xM + y + 1]}\right]$$

Now y may be taken as one if any two succeeding formulæ are taken in any series,

$$\therefore \quad .00094 = xM \left[\frac{1}{(xM + 2)(xM + 1)}\right]$$

Now, since M must be between 1 and 238 [Uranium], let first M = 1,

$$\therefore \quad .00094 = x \left[\frac{1}{(x + 2)(x + 1)}\right]$$

Solving for x; $x = 1060.8$.

That is for a metal of atomic weight 1, the method is reliable to the series $M_{1060}H_y$.

Now let M = 288.

Then

$$.00094 = 238x \left[\frac{1}{(238x + 2)(238x + 1)}\right]$$

Solving for x $x = 5.78$.

Hence the method is not here reliable beyond the series M_5H.

Conclusions.

In the analysis of solid metallic hydrides by vacuum analysis, the method for hydrogen is only reliable to the series M_1H_1, and for metals of atomic weight 1 up to the series $M_{1060}H$ and for atomic weight 238 up to the series M_5H.

Hence all derivations of formulæ of solid metallic hydrdes are on the hypothesis that the formula is of a simpler type in general than the series M_5H.

Finally, it is obvious that the loss in weight of the hydride on heating in vacuo gives more accurate results than the estimation of the hydrogen formed. The latter should only be used as a check on the results and not for formula derivation purposes.

The Battersea Grammar School,
Clapham Junction.

16 December, 1925.

ON THE STRUCTURAL DIAGRAMS OF SOME SPECIAL STEELS.

By Tsutom Kase.

The present writer has recently investigated the diagram of the iron-carbon-nickel system. It was found that iron-nickel alloys containing about 30-34 per cent. of nickel, when cooled from a very high temperature, and on further cooling down to − 190° C., they undergo the A_3 transformation, their structure changing from austentite to martensite, and further that during this transformation these alloys increase in volume and hardness in a marked degree. Hence, if the iron-carbon-nickel alloys be examined by means of a dilometer and a hardness tester, the structural diagram of the ternary system can be easily studied. The object of the present investigation was to determine by the above

methods, the structural diagrams of nickel, manganese, and chromium steels.

The test specimens, each 30 grams in weight, were alloyed in an alumina crucible paced in a Tammann furnace, and cooled in it. Then measurements of the hardness and structure of the following alloys were made :—

1. The alloys cooled from the melt in the furnace;
2. The same alloys as in 1, after being immersed in liquid air;
3. The same alloys as in 2, annealed at 800°-900° C. (above Ac_3) for about 5 hours in vacuum and cooled in the furnace;
4. The same alloys as in 3, after being again immersed in liquid air.

These alloys were also subjected to magnetic analysis, and dilatometric investigation, the specimens being each 5 mm. thick and about 7 cm. long.

The materials nsed for making the alloys were "Hochotetsu," Swedish iron, commercial shot nickel, manganese, chromium, and sugar charcoal. The chemical analysis of these materials is shown in Table 1.

The present investigation may be summarised as follows :—

1. The present writer has investigated the structural diagrams of nickel, manganese, and chromium steels, by examining their scleroscope hardness, microstructure, and transformations by the magnetic and dilatometric methods, especially at low temperatures.

2. Alloys which have completed the Ar_3 (Ar_1, Ar_2) transformation at room temperature, do not undergo any increase of hardness, change of structure, or abnormal expansion, when cooled down to the temperature of liquid air. Those having an austenitic or austenite-martensitic structure, when immersed in liquid air, may be transformed into martensite and expanded abnormally, the hardness thereby increasing.

3. The alloys which make stepped transformations ($Ar_{3,1}$ $Ar'_{3,4,}$) in magnetic analysis, assume some martensitic structure, in virtue of the lower transformation (below 300° C).

4. The structural diagrams of the three special steels determined as above, are somewhat different fro mthose which are well known and were formerly proposed by Guillet. Namely, in these steels cooled slowly from the melt in the furnace, the structural fields after an addition of a small quantity of carbon are bordered by straight lines almost parallel to the axis of the carbon.

In conclusion, the present writer wishes to express his cordial thanks to Professors K. Honda, T. Murakami, and T. Ishiwara for their kind guidance and useful advice throughout this investigation.

(Memoirs, College of Chemistry, Tokio University.)

ON A CLASS OF ONE-VALENCE-ELECTRON EMITTERS OF BAND SPECTRA.

By ROBERT S. MULLIKEN,

(Abstract from "The Physical Review.")

Bands emitted by one-valence-electron molecules.—Series A : *BeF, BO, CO^+, CN, N_2^+*. These molecules each contain, like the Na atom, 8 + 1 electrons outside the nuclei and K electrons. The bands of CO^+ (the comet-tail, negative Deslandres and new quadruple-headed bands reported by Baldet and Johnson) are particularly discussed and analogies to the bands of BO and of CN are pointed out, as well as analogies between the bands of N_2^- and of CN. The data for BeF bands are less complete. The lines of the known band systems of all these molecules can in each case be expressed as combinations of three electronic terms (each of course with a variety of vibrational and rotational states). These are a singlet term *N* probably belonging to the normal state, a doublet term *A* corresponding to the first excited state, and a singlet term *B* corresponding to the second excited state. There is evidence that the average angular momentum of the emitting electron—which is presumahly the odd ninth electron—is the same for the *N* and *B* states, but different for the doublet *A* state; presumably the former resemble *s* states, the latter resemble (inverted doublet) *p* states. In the cases of BO and CO^+, all of the three conceivable combinations between *N*, *A*, and *B*, are known; two are known in the case of CN, and one in that of N_2^+; the systems not yet observed probably lie in the infra-red. There is a remarkable parallelism between the spectra of the several molecules mentioned in respect to structure of analogous band systems and to molecular constants of corresponding electronic states (cf Table I). *Series B: MgF, AlO, SiN.* These molecules contain an additional electron shell. They are the

probable emitters of band spectra which show marked analogies to those of BeF, BO, and CN. *Additional series* of emitters are represented by CaCl, SrBr, etc.

Suggested grouping of bands according to the number of valence electrons of the emitters.—Molecules with no unused valence electrons—HF, LiF, BN, NaCl, etc.—show analogy to the rare gases; they do not emit electronic band spectra. Molecules with two excess electrons—CO; NO^+, N_2, SiO—should show analogies to alkaline earth metals. The odd multiplicity of N_2 agrees with this suggestion. Molecules with three excess electrons, *e.g.*, NO, should resemble Al; in fact the bands probably due to NO show even multiplicity.

Nature of multiplicity in band spectra.—Two causes of multiplicity are suggested: (a) connected with the interaction of the emitting electron with the rest of the molecule, and (b) attributed by Kratzer to the interaction of the angular momentum of the emitting and other electrons with that of the nuclei. Examples of each are discussed.

FLAME SPECTRA AND CHEMICAL REACTION.

By Miss C. E. Blueker.

(Faraday Society, October 1 and 2, 1925.)

A contribution to a general discussion on *Photochemical Reactions in Liquids and Gases*, held by the Faraday Society at Oxford, October 1 and 2, 1925.

Abstract.

Measurements on the relative intensities of several members of the first and second subordinate series in the flame spectra of the elements rubidium and caesium have previously been published[1].

The experiments have shown that the ratio of these intensities depends neither on the concentration of the salt in the flame, nor on its temperature. Also, for this kind of excitation the ratio of the doublets is found to be 2 : 1.

The change in the successive intensities of lines in a series due to temperature variation in the case of thermal excitation may be estimated in the following manner. If T represents the temperature, k the Boltzmann constant, e the energy, and q the statistical weight of the level under consideration, then the number of atoms which are in the state 4S,[2] for the case of temperature equilibrium, may be represented by—

$$q_4 e^{-\frac{e_4}{kT}}$$

while

$$q_5 e^{-\frac{e_5}{kT}}$$

represents this number for the 5S state.

If W_4 and W_5 represent the transition probabilities, then the ratio of the number of possible transitions is given by:—

$$W_4 q_4 e^{-\frac{e_4}{kT}} : W_5 q_5 e^{-\frac{e_5}{kT}}.$$

The ratio $W_4 : W_5$ is generally supposed to be independent of the temperature, and we find for the ratio of the transitions:—

$$Ae^{-\frac{C}{T}(V^1 - V_2)}$$

where

$$C = \frac{hc}{k}.$$

It follows that the variation of this ratio, if we consider two temperatures T_1 and T_2, is given by the formula:—

$$-C(V_1 - V_2)\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

Now for the oxygen flame we may put T = 2700° and for an ordinary bunsen T = 1700°.

For the case of caesium, the variation of the ratio:

$$(\delta_4/\delta_5)_{2700} : (\delta_4/\ _5)_{1700} = 1.65$$

can be expected. The experimental results do not show any variation.

The above-mentioned measurements have been extended to potassium and sodium, and for these alkalis also analogous results have been obtained. The measurements were much more complicated as the lines are situated in less favourable region

[1] Z. für Physik, 1924, Bd. 27, 195.

[2] The notation of Fowler is used.

of the spectrum and therefore the results show much larger mutual deviation than was the case for the heavier **alkalis**.

As the temperature has no influence on the ratio of the intensities, it is impossible for the subordinate series found in flames to be caused by thermal excitation alone. The experiment of Haber, which shows the emission of the D lines of sodium due only to chemical binding of Na with Cl, suggests that in the case of flames also, chemical reaction plays a part. In our case, it is possible that besides temperature-radiation, the oxidation of alkali atoms is the cause of the emission of spectral lines. We can imagine the process in the following way. All the π-levels can be formed by black body radiation from the σ-level, which is the normal state of the unexcited atom. The simplest way of excitation of the other σ- and δ-levels, is by absorption through atoms in the first π state. The number of atoms in this state, however, is very small, *a fortiori* the number of atoms which have an electron in the higher σ and δ-orbits is still smaller. The ratio of the lines due to emission from those levels would, for the case under consideration, depend on the temperature but the lines will be very faint.

CARBON BLACK PRODUCED FROM NATURAL GAS.

By G. B. Richardson.

(*U.S.A. Dept. of the Interior.*)

The production of carbon black from natural gas in the United States in 1923 amounted to 138,262,648 pounds, an increase of 104 per cent. over the production in 1922. The increase resulted from the expansion of the industry that followed the greater demand in 1922 for carbon black by rubber companies. The number of producers of carbon black reporting to the Survey increased from 26 in 1922 to 47 in 1923, and the number of plants operated from 43 to 69. The operations resulted in over-production during the later part of 1923, as indicated by the quantity of stocks held in the hands of producers. Stocks increased from 2,434,547 pounds on January 1, 1923, to 38,320,814 pounds on December 31.

The production by States in 1923 as compared with that in 1922 is shown in a table. Louisiana led all the States in the quantity of carbon black produced, as it has in the last three years, and its output of more than 101,000,000 pounds shows an increase of 142 per cent. over its output in 1922. The production of Kentucky in 1923 increased 134 per cent. The production of West Virginia, on the other hand, declined slightly. Texas joined the States producing carbon black in 1923. The production of Wyoming, Oklahoma, Montana, and Pennsylvania, which ranked in the order named, is grouped together to avoid revealing the operations of individual companies.

POWDERED FUEL.

Its Importance on Boiler Plant Development.

At the Engineering and Scientific Club, Wolverhampton, on the evening of December 11, Mr. F. H. Rosencrants, B.Sc., A.S.M.E., gave a lecture of almost national importance on the development of powdered fuel in America and this country for the purpose of the generation of steam for power purposes.

The lecture was particularly interesting having regard to the important developments now taking place not only in this district, but throughout the country in the erection of super-power stations for the generation of electrical energy on a large scale.

The lecture, which was fully illustrated by an excellent selection of slides, dealt with the early development and difficulties of powdered fuel as applied to the generation of steam, leading up to the most modern installations, fitted with screens, water-cooled side walls, air pre-heaters, radiant heat super-heaters, etc.

Whilst in this country there are few boiler units working having a capacity of 100,000 lbs. of steam per hour, Mr. Rosencrants gave particulars and illustrations of many units working in the U.S.A. having a capacity of 200,000 lbs. and 300,000 lbs. of steam per hour, and at the Ford Car Works there are several boilers of this size, which, after the completion of certain alterations now being effected, will have a steaming capacity of 500,000 lbs. per hour.

An important feature of these large units is the simplicity of control, only one man being required to control four such units as previously described.

Drawing-Room Cleanliness.

Boiler houses are usually associated with dost and dirt, but, in the boiler house referred to, Mr. Rosencrants stated that a

cleanliness was maintained equal to any drawing room.

Owing to the perfect combustion and refinements of powdered fuel installations, efficiencies of 89 to 91 per cent. are being maintained as a daily working condition of the plant.

Mr. S. T. Allen and Mr. J. Hargrove took part in the discussion, and Major S. J. Thompson, who presided, in proposing a vote of thanks, remarked that more information had been supplied by Mr. Rosencrants than could have been gathered in a month's tour of the actual power stations in America.

Owing to the limitation of time available for discussion, an invitaton was extended to Mr. Rosencrants to visit the club again at a later date for the purpose of continuing the discussion, which he promised to do.

SALT AND ALLIED CHEMICALS.

By George E. Gollop,

(*Canadian Salt Company, Ltd., Windsor.*)

Canadian Chemistry and Metallurgy publishes an interesting account of salt, from which we extract the following :—

The Great Salt Bed of South-Western Ontario.

Underlying the south-western section of Ontario and portions of Michigan are salt deposits of vast extent in the Salina formation of the Silurian age. The approximate area of the salt basin in Ontario is about 3,000 square miles. Some interesting calculations have been made as to the quantity of salt in this area, and it has been estimated that there is enough salt here to last the world at its present rate of consumption for 90,000 years. The salt beds vary in thickness, the upper and thinner layers being intersected with dolomite and shale.

At Sandwich we first strike salt at about 1,000 feet. At Royal Oak on the ten-mile Road, a depth of 1,500 feet must be reached, while at Birmingham, eighteen miles out, it is 2,500 feet below the surface.

The salt formation continues to dip rapidly until at the centre of the basin it is about 4,000 feet beneath the surface.

Some of our wells are in this strata, while others extend through to the so-called "deep salt," 1,370 feet down. This bed is 230 feet thick and to give an appreciation of what such a deposit means, a block or square mile of it 230 feet thick would contain over 400,000,000 tons. I have just made a hasty calculation to determine what the depth would be of sea water which upon evaporation would give a deposit 230 feet thick, and it figures in the neighbourhood of two and one-half miles.

As a similar condition to the one existing in that period, we might study what is happening to-day in the great Salt Lake or the Dead Sea. As the sea water becomes more and more concentrated, the most insolnble component comes out first, that will be dolomite, and the other suspended matter that forms shale, then will come down calcium sulphate or gypsum, next will be the salt and then the more soluble compounds, calcium and magnesium chlorides. In our deposits, iodides or bromides, on account of their greater solubility, have escaped to lower levels. At Midland, Michigan, the Dow Chemical Company has been fortunate enough to strike a flow of brine containing commercial quantities of bromine.

As most of you no doubt already know, we bring our salt to the surface as brine. Briefly, the procedure is to sink a well in the manner to drilling one for oil, with this difference; at the proper depth, we always strike salt. The first 700 feet the hole drilled is lined with a pipe ten inches in diameter. An eight-inch pipe continues on down for the next 450 feet, and a six-inch pipe for the balance of the distance of 220 feet, where at a depth of 1,370 feet, we hit the lower or "big salt." A hole is drilled through this salt to the bottom and a three and one-half inch pipe put through from the surface of the ground to the bottom of the salt, 1,600 feet. The well is now ready for pumping, and as joints are all tight, water under a pressure of 175 pounds to the square inch is forced down the larger pipe around the three and one-half inch pipe it contains, and comes up through the latter as brine. The raw brine, after settling and purifying, is run to the vacuum pans, where water is evaporated from it, and salt deposits as fine, pure crystals.

Evaporation of the Brine.

Vacuum evaporation is the most economical method of removing water from brine. Under diminished pressure, the boiling point is lowered. This permits the use of low-pressure or exhaust steam for heat-

ing. The vapour from the first pan goes into the steam belt of the second pan, the air being removed to a sufficient degree to permit boiling. The salt is taken away automatically, while the pan is in operation, and is run into centrifuges, and in three minutes, these machines, running at 3,000 r.p.m., bring the moisture content down to 2.5 per cent. Our three centrifuges have a capacity of over 1,500 barrels of salt per day. Before these machines were installed, the wet salt from the pans was dumped into bins, where the excess moisture was allowed to drain off. For the moisture content to be as low as 2.5 per cent., a draining period of fourteen days was required, and as stated before, this is now accomplished in three minutes by centrifuging.

This treatment removes the mother liquor from the crystals and brings up the purity of salt.

The impression is abroad that coarse salt is a cheaper salt, and therefore, should always be used wherever possible, but that is an error. The only advantage coarse salt can have is grain—fine salt is purer, more compact, cheaper, and for most purposes, decidedly better. As you know—vacuum evaporation is much more economical. Good grainer practice may give twelve to fourteen barrels of salt per ton of coal, while for the same expenditure of energy, about twice the amount of salt can be made.

Salt Dryers.

The next stage in the preparation of the finer grades of salt is drying. Air is drawn through steam coils to pre-heat it, and thence through an inclined rotating cylinder counter current to the flow of salt in process of drying. The temperatures of these dryers is well above the boiling point of water, and this insures a bone dry salt, before it passes over the screens.

LIGHT ABSORPTION AND EMISSION PHENOMENA IN ANTHRACENE.

Abstract.

The above is the subject of a contribution from the Queen's University, Belfast (Ireland), by Norman S. Capper, and Joseph K. Marsh, to the December issue of the *Journal of the American Chemical Society*. The authors shew that for more than 60 years, anthracene has been known to chemists as a colourless substance, possessed of strong violet fluorescence, while the main feature of the absorption spectrum are four bands of about $1/\lambda$ 2655, 2795, 2935, 3075, the first two being the strongest and narrowest. Bands found in anthracent solutions at 445 and 475 $\mu\mu$ by Taylor and Lewis were not the photochemically active ones, but were due to the presence of chrysogen. Hence, the deduction that dianthracent should absorb at 707$\mu\mu$ does not follow, and their evidence brought to shew that light of this wavelength is capable of bringing about a photochemical depolymerisation of dianthracene is inconclusive. The fluorescence is remarkable in its intensity and mode of stimulation.

Trade and General Notes.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.

Physical and Chemical Survey of the National Coal Resources.

An important aspect of the work on fuel research undertaken by the Department of Scientific and Industrial Research is a survey and classification of the coal seams in the various mining districts by means of physical and chemical tests in the laboratory, supplemented where desirable by large scale tests at H.M. Fuel Research Station, East Greenwich, or elsewhere. The Fuel Research Board of the Department consider that the best way to carry out this work is by means of local committees representing the local colliery owners and managers, the local branch of the Institution of Mining Engineers, the Fuel Research Board, and the Geological Survey of Great Britain as well as outside scientific interests. Each committee is charged with the duty of supervising the work of the physical and chemical survey in a coal mining area; and in this way the survey becomes of practical value from the commencement, since local knowledge and experience are made available, and the seams to be investigated and the general programme of work are decided by those who are able to estimate most correctly the relative importance of the problems to be solved. The seams selected undergo physical and chemical examination by local investigators appointed for the purpose, after which a final selection is made of those seams likely to justify experiments

on a technical scale in order to test their suitability for particular uses or methods of treatment.

Committees have for some time been actively at work in the Lancashire and Cheshire and in the South Yorkshire areas. The Department recently appointed a committee for work in the North Staffordshire Area.

A further committee has now been formed to deal with the survey of the coalfields of Scotland. The coalowners of Scotland and the Mining Institute of Scotland are co-operating in this work, and the composition of the Committee is as follows :

Representing the Coalowners of Scotland—

Lanarkshire Coal Masters' Association,— Mr. R. Forrester, Mr. W. Thorneycroft, Mr. J. Robertson.

Fife and Clackmannan Coal Owners' Association.—Mr. C. A. Carlow.

Lothian Coal Owners' Association.—Mr. J. Clark

Ayrshire Coal Owners' Association.—Mr. Mr. Brand.

Representing the Mining Institute of Scotland—

Professor T. Gray; Mr. M. Macgregor (Assistant Director for Scotland, Geological Survey); Dr. C. H. Lander (*ex officio*) Director of Fuel Research; Mr. F. S. Sinnatt (*ex officio*) Superintendent of the Physical and Chemical Survey of the National Coal Resources.

HOSPITALS IN ENGLAND AND JAPAN.

On December 17, Prince Chichibu visited Westminster Hospital, London, being accompanied, among others, by Surgeon-Lieut.-Col. J. Nakamura, Physician in Waiting to the Imperial Household of Japan. The Prince thoroughly explored the hospital.

Colonel Nakamura said there was a voluntary hospital in Tokyo supported by the munificence of a member of the Mitsui family, and besides this there were municipal and military hospitals. He found little difference between the London hospitals and those of his own country, which had been largely modelled on German lines before the war, but thought the wards and kitchens finer than those in his own hospital. He mentioned that cancer research was being carried on, and that the Japanese specialised in histological work.

GERMAN CHEMIST DISTILS PETROL FROM COAL.

It is authoritatively stated that a German scientist has solved the problem of distilling petrol from coal. It will take some little time to get this new invention working commercially, but when that time arrives the result will be to revolutionise the colliery industry. More and more coal will be wanted, and in Great Britain enormous savings will be effected by substituting coal-distilled petrol for oil imported from abroad.

HELIUM GAS IN ONTARIO.

The Ontario Government has made announcement of the fact that a deposit of helium gas has been discovered at Inglewood, about 40 miles from this city. Three wells have been taken over by the Government at a cost of $40,000, and for some time helium gas has been extracted from them in co-operation with the University of Toronto. The discovery of helium at Inglewood was made as a result of the wartime investigations of the Department of Mines, but in view of its importance it was felt advisable to keep it a secret until the province was able to take the gas well over.

KAOLIN DEPOSITS IN ONTARIO.

Extensive china clay deposits have been discovered at what will be known as Kaolin City, 70 miles north of Cochrane, in Northern Ontario, and a company has been formed for the purpose of developing 400 acres of the property. An initial plant, with a production of 500,000 tons per year, is stated to be in contemplation ,to be ready by the middle of 1926. The deposits are said to consist of china clay, silica sand and fireclay. Mr. H. S. Hancock, engineer, has reported that, in his opinion, this deposit, if exploited properly, will completely dominate the world's china clay market because of its purity, quantity, and cheapness.

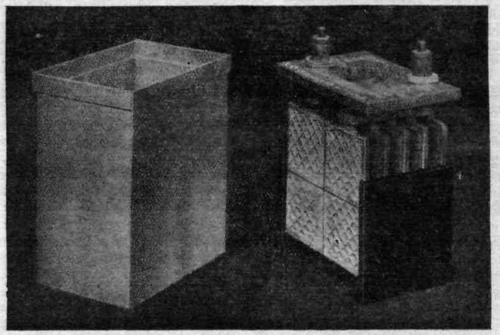
SMOKE ABATEMENT LEAGUE OF GREAT BRITAIN.

The sixth report gives a record of the various activities of this useful body. There is an influential Council, while affiliated with it are several local authorities. The address of the Hon. Secretary is 33, Blackfriars Street, Manchester.

THE TUNGSTONE ACCUMULATOR.

Of Interest to Motorists and Others.

After many experiments, the proprietors of Tungstone accumulators (for all trades) claim to have produced an article that is in all respects reliable, and one which has successfully passed through the ordeal of the most exacting tests—tests made to discover, if possible, any imperfection. It was a capital idea of the proprietors to prove by practical tests the worth of Tungstone before submitting it to the general public. Some of the features of Tungstone —Exceptional mechanical strength;the die-cast grids and plates will withstand continuous electrical activity and ruggedness; the seamless indestructible metal container



Above shews 2-volt cell, with nine plates, 4″ × 4″, weight without acid, 12 lbs., or with acid, 14¼ lbs. Interchangeable for car or wireless.

defies acid, heat, corrosion, and car vibrations; the pure lead units are cemented together in one operation on all sides by a thin bar of liquid antimonial lead, pressure-fed into the recessed and hidden grooves of the outer edges of each unit; die interchangeability; accessibility, stability and standardisation of all sections are very important features which are observed in the manufacture of the Tungstone accumulator

The weight of the Tungstone, costing £5 15s., is only 23 lbs (60 volt, 3 a.h. high tension). The price includes a free first partial charge, polished teak box, indestructible acid-resisting metal filler. The cost, it will be seen, is only 1s. 11d. a volt, or a little over half the price and only about one-third the weight of other makes. The life of the plate is normally from six to ten years. The advantages claimed for the Tungstone accumulator are backed up by ample guarantees.. It is supplied by the Tungstone Accumulator Co., Ltd., of 3, St. Bride's House, Salisbury Square, London, E.C.4.

Block shews printed instructions pasted inside the removable wood lid, of 60-volt, 3 a.h. High Tension Battery.

PROCEEDINGS AND NOTICES OF SOCIETIES.

FARADAY SOCIETY.

On Chemiluminescence, by H. KAUTSKY (Berlin-Dahlem).

(A contribueion to a general discussion on "Photochemical Reactions in Liquids and Gases," held by the Faraday Society at Oxford, October 1 and 2, 1925.)

ABSTRACT.

Haber and Zisch have investigated the luminescence caused by the combination of sodium vapour with chlorine and have explained it theoretically. My colleague, Dr. Zocher, and I, gave independently a similar explanation for the extraordinary bright chemiluminescence which is caused by the oxidation of silikone at room temperature. (Silikone is a yellow solid substance, a mixture of siloxen ($Si_6O_3H_6$) and several coloured reaction products of siloxen.) This explanation may be expressed briefly in the following way. The energy which is set free in any chemical reaction remains first associated with the reaction products. In the simplest case of chemiluminescence the reaction product itself may give off its energy, or at least a part of it, in the form of radiation. In other cases we may first have a transfer of energy without radiation from the reaction products on neighbouring molecules. 8hese molecules may be molecules which take part in the reaction, or molecules of another kind. By this transfer of energy, they are transformed into an unstable active modification, richer in energy, and light is emitted when they return to their normal states.

Chemiluminescence is therefore the reversal of a photochemical or a sensitised photochemical reaction. Here the absorption of light causes directly a chemical reaction, or in the case of sensitation it causes a chemical reaction in consequence of a transfer of energy on neighbouring molecules. Chemiluminescence only differs from fluoresence in so far as the activation is of a different kind. In the case of chemiluminesence it is the energy of a chemical reaction which causes the radiation, in the case of fluoresence it is the absorbed light which has the same effect.

It therefore ought to be possible to force a substance which shows fluoresence to give chemiluminesence by using suitable reactions for activating its molecules. We might expect then that the spectrum of chemiluminesence would be identical with the spectrum of fluoresence. Experiments were therefore made to force fluorescent dyestuffs like rhodamine and rhodamine sulphonate to give chemiluminesence. In order to attain this end the following conditions have to be fulfilled. We need a reaction which gives the energy necessary to activate the dyestuffs and which does not change their emission of light. We further need conditions in order that the transfer of energy from the place of reaction to the molecules of the dyestuffs is thorough and effective. These conditions are fulfilled by some solid colourless derivatives of silicon, for instance silio-oxalic acid, siloxen and some colourless oxidation products of siloxen. These latter derivates of silicon have a strange morphological structure. They are built up out of lamellæ consisting of layers of molecules only one or two molecules thick. These layers lie over one another like the leaves of a book. They adsorb basic dyestuffs in water solution. The adsorption compounds are strongly coloured and show fluoresence. The lamellæ themselves may be oxidised by adding small amounts of potassium permanganate in acid solution without showing luminesence and without change in their morphological structure. The energy of this oxidation is easily transferred to the dyestuff molecules since they are adsorbed on the lamellæ. They are, therefore, in the direct neighbourhood of the places of reaction.

The chemiluminesence which is caused by adding a solution of permanganate to these adsorption compounds is surprisingly bright. The same chemiluminesence is found if these adsorption compounds, in a dry state, are oxidised with ozone. This shows that it is the adsorbed dyestuff which causes the chemiluminesence. The dyestuffs were made to fluoresce by illuminating them with ultra-violet light. There was no difference between the fluorescent spectra of the adsorption compounds and of the dyestuffs in solution.

The above-mentioned theory was verified quantitatively in so far as the chemiluminescent spectra of rhodamine and rhodamine sulphonate were found to be identical with their fluorescent spectra.

INSTITUTE OF ELECTRICAL ENGINEERS.

Frequency Variations in Thermionic Generators, by LIEUT-COL. K. E. EDGEWORTH, D.S.O., M.C., Royal Signals, Associate Member.

SUMMARY.

The paper is divided into six parts, as follows :—

In Part I the variations of frequency which occur in mechanical oscillating systems with pendulum control are referred to. Unless the driving impulses are given at the moment the pendulum is vertical, the frequency of the oscillations varies from the true oscillation frequency of the pendulum. When the pendulum is near the limit of its swing an impulse directed inwards makes the clock go fast, while an impulse directed outwards makes the clock go slow. Such an effect is " reversible " because the clock goes fast or slow according to the direction in which the impulse is applied. Another type of variation is connected with the amplitude of the swing, and makes its appearance unless the amplitude is infinitesimal. Increase of amplitude always makes the clock go slow, and the effect is therefore " irreversible."

In Part II. the phase relationships of currents and potentials in a thermionic generator are examined, and it is shown that the frequency of the oscillations is affected by the nature of the coupling between the grid and anode circuits. Equations are obtained which give the difference between the frequency of the oscillations generated and the resonant frequency of the tuned circuits. These equations show that the variations of frequency connected with the method of coupling are analogous to the reversible variations existing in the pendulum-controlled clock. With normal coupling the thermionic generator goes slow, with reversed coupling it goes fast, and with resistance coupling the variation disappears .

In Part III., three " irreversible " variations of frequency are discussed, namely :—

(i) A variation connected with a change in the effective inductance of the circuit which occurs when the oscillation is free instead of forced;

(ii) A variation connected with a change in the resonant frequency of a damped circuit which occurs when the oscillation is free instead of forced; and

(iii) A variation associated with the presence of harmonics in the E.M.F. generated by the valve.

In Part IV. certain points in the design of thermionic generators employing resistance coupling are discussed.

In Part V. the design of thermionic generators using reversed coupling is discussed, and some interesting points affecting the design of untuned circuits are described.

In Part VI. the experimental results obtained with various types of circuit are given, and are explained in terms of the theoretical variations discussed in Parts II. and III.

The characteristics of various types of constant-frequency generator are then compared. It is pointed out that frequency variations associated with changes in the voltage of supply can be reduced below 1 part in 20,000, or 1 part in 50,000, according to circumstances.

THE OPTICAL SOCIETY .

At a meeting of the Optical Society, held on December 10, 1925, Mr. T. Smith, President, in the chair, the following papers were presented and discussed :—

General Principles of Photographic Surveying, by COL. H. S. L. WINTERBOTHAM, C.M.G., D.S.O., R.E.

The paper gives a brief outline of the development of photogrammetry from terrestrial and aerial positions, and an indication of some of the points to be considered in the design of instruments required by the photogrammetric surveyor in this country. The instruments originally used, such as the Canadian type of survey camera, were of the nature of photographic theodolites. No optical machinery was available for utilising the views taken by the camera. It was soon established that the use of stereascopy facilitated the identification of points common to different views. The introduction of the Zeiss comparator with its movements of one plate relative to the other (parallactic angle), of both plates sideways (orientation), of both plates up and down (height), led to a considerable reduction in the time of plotting and greatly improved contouring. The stereoautograph of von Crel embodied the optical properties of the comparator, and in addition, mechanical arrangements which enabled the observer to plot mechanically, the time required to plot one point

being reduced from 5 minutes to 1 minute. In the case of photographs taken by a simple camera in the air, it is difficult to reconstruct a 3-dimensional landscape from a 2-dimensional picture, unless the points of exposure have been established. Optical mechanical instruments are now in course of construction which will do for surveys from the air what the stereoautograph of von Crel does from photographs from the ground.

Perspective Conditions of Photogrammetry, by LIEUT-COL. W. N. MACLEOD, D.S.O., M.C., R.E.

The perspective conditions which must be satisfied in aerial survey work are discussed and the methods of reconstructing these conditions from the photographs obtained are described, reference being made to such instruments as the rectifying camera, the tilt-finder, the photogoniometer and the plotting machine. Attention is drawn to the desirability of designing new apparatus with which to carry out the necessary reconstruction with the requisite accuracy.

Some Precision Problems in Air Survey, by LIEUT. M. HOTINE, R.E.

Various problems are considered with regard to cameras for use in the air, for example, the lens and its calibration, the time available for exposure, the construction of a shutter which has to be subjected to sudden alteration of temperature and constant vibration. The factors upon which accuracy in air survey measurements depends are described, and suggestions are made as to some of the conditions which should be fulfilled in apparatus employed for such measurements.

ROYAL INSTITUTION OF GREAT BRITAIN.

21, Albemarle Street, London, W.1.

THE TRADE OF THE WEAVER.

The weaver has to make the best of certain products, few in number, which he has found in nature and can adapt to the needs of men for clothes and coverings of all kinds. It is true that we now make artificial silk, but wool and cotton, natural silk and flax make up most of the materials that we use. Modern mills really continue, though on a grand scale, the same treatment of the fibre or hair as the hand-worker of ages ago. The weaver has simply accumulated a vast experience of methods, and of useful and pleasing results. Modern attempts to carry the trade further still go down to the properties of the individual fibre and find there a number of interesting and highly important questions. — *Sir William Bragg, F.R.S.*

THE TRADE OF THE DYER.

The dyer, like the weaver, made use for ages of a certain limited number of substances which he found in nature: indigo, madder, woad, and so on. But of late years he has broken loose from the restrictions that bound him. He has found out the essential features of the dye molecule. He can not only make the original dyes for himself, but thousands of others also. He has a wealth of shades at his disposal, but still the number of important and interesting problems he would like to solve is as great as ever.—*Sir William Bragg, F.R.S.*

GEOLOGICAL SOCIETY OF LONDON.

At the ordinary meeting on December 16, the President, Dr. J. W. Evans, presided.

The following communication was read:

The Black Marl of Black Ven and Stonebarrow, in the Lias of the Dorset Coast, by WILLIAM DICKSON LANG, Sc.D., F.G.S., AND LEONARD FRANK SPATH, D.Sc., F.G.S.

The Black Marl Series of the Geological Survey includes Oppel's zones of *obtusus*, *oxynotum*, and *raricostatus*. The lowest part of the series—the Shales-with-Beef, has already been described in detail. Careful collecting has made it possible to recognise at least the following twelve horizons in the Black Marl above the Shales-with-Beef; as well as two non-sequences:—

Beds containing *Epileroceras exhæredatum*. (Base of the Belemnite Marl Series.)

Non-sequence, including the zones of *Metechioceras aplanatum* and *Leptechioceras macdonnelli*.

(l) Beds containing *Echioceras* spp. (sensu lato) and *Deroceras* spp.

(k) Beds containing *Deroceras armatum* and allied forms.

(j) Beds containing *Eoderoceras bispinigerum*.

(i) Beds containing *E. bispinigerum* and *Crucilobiceras densinodulus*.

(h) Beds containing *C. densinodulus* and *Oxyniticeras lymense*.

Non-sequence, including (at least) the zones of *Oxynoticeras oxynotum*, *Bifericera sbifer*, *Oxynoticeras simpsoni*, *Angu-*

Laticeras lacunatum, *Eparietites denotatus*, and *Prederoceras ziphus*.

(g) Beds containing *Asteroceras stellare* and allied forms.

(f) Beds containing *Epophioceras*.

(e) Beds containing *Aseeroceras margaritoides*, *Xipheroceras dudressieri*, *Promicroceras planicosta*, and *Cymbites lævigatus*.

(d) Beds containing *Asteroceras obtusum* and allied forms, and *Promicroceras precompressum*.

(c) Beds containing *Promicroceras pyritosum*, *P. capricornoides*, and *Microderoceras inexpectans*.

(b) Beds containing *Arietites turneri* and allied forms, and *Promicroceras capricornoides*.

(a) Beds containing *Arietites turneri* and allied forms, *Promicroceras capricornoides*, *and Micro deroceras* aff. *birchi*.

The new forms named above are described by Dr. Spath.

New species of ammonites from the Black Marl are described. Notes are also added by Dr. A. E. Trueman on the Echioceratid ammonites; by Mr. L. R. Cox on the lamellibranchs; and by Miss H. M. Muir-Wood on the brachiopods.

DISCUSSION.

Dr. A. E. Trueman said that all interested in the stratigraphy of tbe Lias were indebted to the authors for their detailed investigation; he believed that their researches would produce results which would be of value to those working on the zonal succession of other rocks. During the past twelve years Dr. Lang's painstaking researches had provided a new basis for the study of ammonite distribution.

A suggested sequence of ammonite faunas within some of the zones dealt with in the present paper was put forward by Mr. S. S. Buckman in 1920; that sequence was partly the result of analyses of the records made by Mr. L. Richardso during the construction of the Cheltenham-Honeybourne Railway. Recently, the speaker (with Miss D. M. Williams) had re-examined Mr. Richardson's ammonites, and in several ways their views confirmed the faunal sequence given by the authors. In particular, the Echioceratid ammonites from Cheltenham were regarded as newer, and not older, than the Echioceratid faunas of Dorset; the *Microceras subplanicosta* and associated faunas were still newer. In other words, certain horizons regarded by Mr. Buckman as occurring (in time) between *g* and *h* of Dr. Lang's table, are probably to be regarded as above his *l*. The occurrence of species of *Gleviceras* recorded by Dr. Lang in the *Raricostatus* Zone supports this view, for *Gleviceras glevense* occurs below the horizon with *Microceras subplanicosta* in Gloucestershire. It was however, noteworthy that *Gleviceras glevense* in Gloucestershire is not known to be associated with raricostate Echiocera. tids.

The problems of correlation of the Lower Lias were not likely to be solved until much more work of the same type as that recorded in the paper now presented had been carried out in other areas.

Mr. L. R. Cox, Dr. A. M. Davies, Mr. R. S. Herries, Dr. L. F. Spath, and Mr. Errol Ivor White, B.Sc., took part in the discussion.

THE PHYSICAL SOCIETY OF LONDON.

AWARD OF DUDDELL MEDAL.

This medal has been awarded to Mr. Albert Campbell, B.A., late of the National Physical Laboratory, in recognition of his many contributions to the science of instrument design.

NOTICES OF BOOKS.

Applied Chemistry (*A Handbook for Students of Household Science and Public Health B.C.*), by KENNETH TINKLER, D.Sc., F.I.C., and HELEN MASTERS, B.Sc. Vol. II.—Foods. Pp. IX. + 276. Price 15s. net. London: Crosby, Lockwood and Son, 7, Stationer's Hall Court.

At a time when the food question is very much before the public, the publication of an authoritative book on this subject is very welcome and oportune. The present work deals in a comprehensive manner, scientifically, and also in a manner within the comprehension of any intelligent reader, witb the various subjects dealt with in the ten chapters—milk, edible oils and fats, carbohydrate foods, raising agents, meat, etc., vinegar, fruit juices and vegetable acids, beverages, the preservation of food, poisonous metal in foods, the cooking of food. The calorific value of foods are carefully examined under their respective chapters. There are 20 illustrations, and an exhaustive alphabetical index for easy reference. The authors are to be congratulated on the production of a valuable book, not

only for those for whom it was written, but also for a much wider public.

The plan of the work will be understood from a cursory glance at Chapter I., which deals with cows' milk, which is described as a yellowish-white opaque fluid, with a specific gravity of 1.027 to 1.035. The amount of fat in different samples of milk varies from 2.7 to 7 per cent. by weight of the milk. The carbohydrate present in the milk is lactose, or milk sugar, $C_{12}H_{22}O_{11}$, which is present in true solution. The general characteristics of milk are given in some detail. The legal standard requires 3 per cent. by weight of milk fat, and not less than 8.5 per cent. by weight of solids other than fat, and it must be free from preservative or colouring matter. The specific gravity of milk at 60° F. (15.5° C.), is between 1.027 and 1.035 (water at 60° F. = 1). Water being specifically lighter than milk, it follows that the addition of water to milk decreases its specific gravity. Milk fat is specifically lighter than water, and so the removal of cream increases the specific gravity of milk. Specific gravity is no criterion as to the purity of milk, and a proper admixture of skimmed milk and water produces a liquid of the same specific gravity as milk of the legal standard. Methods of determination of ash, solids, fat, etc., in milk are set out in simple language. Illustrations of the various apparati are given, and the determination of lactose, etc., etc., are described. Several pages are devoted to the subject of preservatives in milk, while cream, condensed milk, milk powders, receive due attention.

THE NATIONAL RESEARCH COUNCIL.

The National Academy of Sciences and the National Research Council of the United States, announce the forthcoming publication of International Critical Tables of numerons data of physics ,chemistry and technology.

In making the publication contract, the National Research Council has reserved to members of scientific and engineering societies, and to libraries and research laboratories, for a certain period, the right to purchase the volumes at the estimated mannfacturing cost.

The work of compiling international critical tables was undertaken by the National Research Council at the request of the International Union of Pure and Applied Chemistry, with the endorsement of the International Union of Pure and Applied Physics, and under the asupices of the International Research Council.

The material contained in International Critical Tables has been collected and critically evalued by some 300 co-operating experts, including chemists and engineers of the United States, Canada, Great Britain, Belgium, France, Italy, Austria, Germany, Denmark, Switzerland, Holland, Australia, and Japan.

The estimated cost of producing the five volumes, of 2,500 pages, will be about 570,000 dollars, and the price will be 60 dollars the set; but persons who are members of recognised technical or scientific societies, can secure not more than one set. each individual at 35 dollars the set of five volumes. Educational institutions, public libraries, Government Departments, and research laboratories, can purchase sets for their own use at the reduced price until the appearance of the work early in the New Year. No orders can be received through agents or bookdealers. The address of the National Research Council is "B and 21st Streets, N.W., Washington, D.C., U.S.A."

FORTHCOMING EVENTS.

ROYAL SOCIETY OF ARTS.

Wednesday, January 13, at 3 p.m. (Dr. Mann Juvenile Lecture). Professor Henry Edward Armstrong, LL.D., Ph.D., F.R.S., "Alice in Wonderland at the Breakfast Table." (Lecture II.)

Monday, January 18, at 8 p.m. (Cantor Lecture). H. P. Shapland, A.R.I.B.A., late editor of the *Cabinetmaker*, "The Decoration of Furniture." (Lecture I.)

THE PHYSICAL SOCIETY OF LONDON.

Imperial College of Science, Institute Road, S. Kensington, London.

January 22, 1926, at 5 p.m., the following papers will be read :—

"A Critical Discussion of the Determination of the Mechanical Equivalent of Heat," by Prof. T. H. Laby, M.A., Sc.D., F.Inst.P.

"The Present Status of Theory and Experiment Relating to Specific Heats and the Chemical Constants," by F. Ian G. Rawlings, B.A.

UNIVERSITY SECRETARY WANTED.

The Queen's University, Belfast, seeks a secretary; salary, £750 per annum and non-contributory pension. Applications must reach the Vice-Chancellor by January 30, 1926.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

The ninetieth general meeting will be held at the House of the Royal Society of Arts, John Street, Adelphi, London, on Tuesday, January 12, at 5.30 p.m. J. Stanley Lewis, B.Sc., will read a paper on "The Vapour Pressures of Fuel Mixtures, Part II." Afterwards, Professor J. S. S. Brame will open a discussion on "The Estimate of Unsaturated and Aromatic Hydrocarbons."

North-eastern Section, at the Armstrong College, Newcastle-on-Tyne, January 11, at 7 p.m. Informal discussion on "Switchgear for Large Power Stations," opened by Mr. L. E. Mold and Mr. A. G. Shearer.

Dundee Sub-Centre, January 14, at 7.30 p.m., at University College, Dundee. W. M. Mackay, "Atmospheric Electricity."

North Midland Section, Hotel Metropole, King Street, Leeds. January 12, at 7 p.m. W. E. Burnard, on "Invention and Patents."

Scottish Centre, at North British Station Hotel, Edinburgh. January 12, at 7 p.m. "Electricity and Tariffs," by H. M. Sayers.

THE WELLINGTON DIARY.

From Wellington and Ward, Ltd., of Elstree, Herts., and 101, High Holborn, London, comes a neat crocodile-covered vest-pocket diary for 1926, which contains a good deal of useful information, especially for those interested in photography.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

31,950.—L. G. Farbenindus Akt-Ges.—Manufacture of chromates. December 17th.

32,046.—Celite Co.—Manufacture of an inorganic chemical product. December 18th.

31,646.—Heffner, L. W.—Recovery of phenols from ammoniacal liquor. December 15th.

31,885.—Macklillgin, A. M.—Cyanide processes of extracting metal. December 17th

Specifications Published.

243,405.—British Aluminium Co., Ltd., Gwyer, A. G. G., and Phillips, H. W. L.—Alloys.

221,226.—Austerweil, G.—Process for the preparation of thymol from 2-cymidine.

243,510.—Soc. of Chemical Industry in Basle.—Manufacture of esters of unsaturated acids.

218,679.—Kahn, M.—Manufacture and extracting of nitrogenous products from products of vegetable origin, and especially yeast.

243,801.—Sauer, J. N. A.—Activated carbon for medicinal purposes.

243,978.—Dow Chemical Co.—Method of producing anhydrous magnesium chloride.

232,612.—Wyld, F. Lehnhoff.—Process for the manufacture of organic arsenic compounds.

243,990.—Meyerhofer, A. F.—Process of producing soluble carbonates and hydrates.

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Publisher's Announcements.

The following Books can be obtained from Rea and Inchbould, Merton House, Salisbury Square, London, E.C.4.

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THE CHEMICAL NEWS,

VOL. CXXXI. No. 3431.

MERTON HOUSE, SALISBURY SQUARE,
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AN INVESTIGATION ON THE GREEN COLOR OF TUNGSTIC OXIDE.

By NICOL H. SMITH AND HIRAM S. LUKENS.

Contribution to the "Chemical News" from the John Harrison Laboratory of Chemistry, University of Pennsylvania, Philadelphia, Penna, U.S.A.

Much has been said concerning the green colour tungstic oxide assumes on ignition. Roscoe attributes the discoloration to the presence of small traces of sodium salts, which are almost impossible to remove by washing. Von J. v. Leimpt* attributes the discolouration to the action of dust particles in the air, this action being greatly influenced by light. Others give reducing

(*Continued top of Column 2.*)

burner gases as the cause of discoloration. As to the extent of error produced by this discoloration, no definite results have been obtained. v. Leimpt attempted a determination of the extent of error, but obtained negative results. The green oxide is considered to be a mixture of a reduced tungsten oxide, presumably W_2O_5, which is blue in colour, and the yellow oxide, WO_3, and has appeared in the literature as a hypothetical oxide, W_3O_8.

The object of this investigation was to determine the extent of error produced by the discoloration of the yellow WO_3 Determinations were first made to see if the ignited green oxide could be oxidised in a current of oxygen to the yellow oxide. Several samples of tungstic oxide were obtained, varying from a light green colour to a dark green colour, by precipitating the tungstic acid from hot solutions of normal sodium tungstate with hydrochloric or nitric acids and washing out the sodium salts as much as possible. No change in weight or colour was perceptible after heating in the current of oxygen. The oxide was placed in a boat and heated in a silica tube at the highest temperature obtainable from a Teclu burner. The following table gives the results obtained :—

TABLE I.

Wt. of oxide	Initial Wt. of boat and oxide	Wt. after heating in O_2 ½-hour	Wt. after heating in O_2 1 hour	Change: In weight	Change: In colour
1.4258	4.9997	4.9995	4.9995	−0.0002	none
1.2354	4.8098	4.8099	4.8099	+0.0001	none
1.3686	4.9430	4.9430	4.9431	+0.0001	none
1.3598	4.0988	4.0987	——	−0.0001	none
1.1043	3.8358	3.8358	——	0.0000	none

v. Leimpt states that the unignited green oxide can be oxidised in a current of oxygen, but on strong ignition the oxide sinters together and forms large particles, thereby preventing access of oxygen to the green oxide. During the ignition of the oxide it was noticed that a certain amount of sintering did occur. Is this not more likely to be due to the presence of sodium salts than to the sintering of the much more difficultly-fusible substance, tungstic oxide? These sintered particles were always deep green in colour and the impurities appeared to be concentrated in these particles. Samples of the oxide were examined under a microscope and no distinction could be made between the green and the yellow oxides. The particles appeared to have sharp and angular edges. They were magnified 228X.

Impurities such as molybdenum, vanadium and manganese were looked for and were found to be absent. The sodium tungstate used, however, contained traces of iron. All the samples of green oxide shewed the presence of sodium salts in varying quantities, as indicated by the flame coloration. The yellow oxide thus far obtained contained only traces of sodium salts. Dilute solutions of ferrous sulphate and manganous sulphate were prepared and two or three drops of these solutions were added to the yellow oxide, and

* Z. Anorg Chem. 119-310 (1921).

these failed to produce the green oxide on ignition.

Since it has been shown that sodium salts are invariably present when the oxide is green, the next step was to prepare a yellow oxide free from sodium salts from a green oxide. Ten grams of sodium tungstate were dissolved in 200 c.c. of water, and heated to boiling. 50 c.c. of concentrated nitric acid were added and the precipitated tungstic acid allowed to settle. The tungstic acid was washed by decantation with 2,600 c.c. of water and finally baked at 120° C. The baked oxide was then divided into two portions. The first portion was strongly ignited in a porcelain crucible and it changed to a deep-green colour. The second portion was dissolved in ammonium hydroxide. It was necessary to warm the solution to get all the baked oxide in solution. In this solution there is *only a very small amount of sodium salts.* The solution was diluted to 1,600 c.c., and the tungstic acid precipitated by hydrochloric acid. The tungstic acid was allowed to settle, the solution decanted and washed *once* with hot water containing hydrochloric acid. The tungstic acid was then dried and any ammonium salts remaining were expelled by ignition. The oxide remaining had a *bright lemon-yellow colour,* and gave no test for sodium salts in the flame. Hence, it is shown definitely that the deep green colour of the tungstic oxide is caused by the presence of sodium salts.

During these precipitations of tungstic acid from sodium tungstate solutions by acids, it was observed that varying shades of green could be obtained by using varying concentrations of sodium tungstate solutions and acid. It was found that the white dihydrated tungstic oxide had a greater tendency to cling to sodium salts than the yellow tungstic oxide. The following table shows the concentrations of acid and sodium tuugstate used. In all precipitations ten grams of normal sodium tungstate were used.

TABLE II.

	H_2O	Acid	Conditions	Colour: Precipitated Acid	Colour: Ignited Oxide
1.	300 c.c.	100 c.c. HNO_3	Pptd. in cold. Heated to boiling	Yellow	Yellow
2.	300 c.c.	100 c.c. HCl	Pptd. in cold Heated to boiling	Pale-cream yellow	Pale greenish-yellow
3.	200 c.c.	50 c.c. HCl	Pptd. from hot solution	Creamy-white	Deep green
4.	200 c.c.	50 c.c. HNO_3	Pptd. from hot solution	Creamy-white	Deep green

Previous to this it had been a matter of chance to obtain a dark green or a fairly good yellow tungstic oxide. By using procedure (4) of the preceding table, a deep green oxide could always be obtained. In all these precipitations the tungstic acid was washed with 2,500 to 3,000 c.c. of water by decantation. In *procedure* (3) and (4) it was not possible to change the creamy-white colored tungstic acid to the deep yellow tungstic acid by heat or by the *addition of more acid.* It was also observed that the baked oxide of procedure (4) on ignition evolved nitric oxide fumes; also the baked oxide of procedure (3) on ignition evolved hydrochloric fumes. This would seem to indicate that tungstic acid was replacing nitric acid or hydrochloric acid from their corresponding salts. To test this out, two or three drops of a sodium chloride solution were added to a yellow sample of tungstic oxide which had previously been ignited. On strong ignition, acid fumes were detected and the yellow oxide changed to the green oxide.

The next step was to determine the amount of sodium salts producing these varying colorations. The following procedure was carried out in all determinations. The ignited tungstic oxide was weighed in a boat and heated in a current of hydrogen at the lowest temperature possible to affect a reduction. It was not necessary to reduce it all to metal. The hydrogen apparatus was then disconnected and a chlorine generator attached. The tungsten was volatilised at a low temperature as oxy-chlorides and collected in the

cool part of the tube. The residue of sodium chloride remaining behind was perfectly white and gave a persistent yellow colour to the flame. The boat was re-weighed and the residue reported as sodium chloride. The following table gives the results obtained using various colored tungstic oxides from deep green to yellow:

TABLE III.

Wt. of oxide	Color of oxide	Wt. of residue	% NaCl.
0.6378	deep green	0.0047	0.74
0.5076	pale green	0.0008	0.16
0.4831	pale green	0.0006	0.13
0.5494	greenish-yellow	0.0003	0.055
0.8074	yellow	0.0003	0.037
0.6817	yellow	0.0002	0.03

v. Leimpt has stated that light has a discolorising effect upon yellow tungstic oxide. Experiments were next carried out to determine whether the production of the green oxide was a photochemical reaction greatly accelerated by the presence of sodium salts or if it was due to the presence of sodium salts alone. A yellow oxide was prepared according to procedure (1) of Table II. The oxide contained only traces of sodium salts. It was exposed to diffused sunlight, and only turned a very pale greenish-yellow colour. Beneath the surface, the tungstic oxide was still yellow.

Tungstic oxide was next prepared free from sodium salts by the ammonium hydroxide method previously described. This, on exposure to direct sunlight, only received a superficial pale greenish-yellow coating. No change in weight was noticed with this slight color change.

Green tungstic oxide was next prepared according to procedure (3) of Table II., and divided into two portions. The first portion was ignited in diffused sunlight. On ignition, the tungstic oxide assumed a deep green colour. The second portion was ignited in a dark room and allowed to cool in the dark. The oxide was also dark green in colour, and could not be distinguished from the oxide obtained by igniting the first portion. Hence, light has no appreciable effect upon the tungstic acid, and the material change of the tungstic oxide is due to the presence of sodium salts.

As an item of interest, during the evaporation of a solution containing an ammonium tungstate, ammonium chloride, ammonium hydroxide, and sodium chloride, a shiny crystalline solid separated out. This was recrystallised and an analysis, corresponded closely to a sodium ammonium complex prepared by Gibbs*, having the complex formula

$$10\ WO_3.4\ Na_2O + 4(10\ WO_3.4\ (NH_4)_2O) + 50\ H_2O.$$

The salt, which was separated out, was dried at 105° C., and the anhydrous salt analysed. Calculated to anhydrous salt: WO_3 91.50%, Na_2O 1.95%, and $(NH_4)_2O$ 6.55%; found: WO_3 91.33%, Na_2O 2.22%, and $(NH_4)_2O$ 6.45% by difference.

This salt, on gentle ignition, loses ammonia, and assumes a dirty yellow color, from which it is not possible to extract all the sodium salts. On strong ignition it assumes an intense green colour. This gives conclusive proof that sodium salts produce the green oxide.

SUMMARY.

1. Ignited green tungstic oxide cannot be oxidised in a current of oxygen to a yellow oxide.

2. It has been shown definitely that the deep green color of the tungstic oxide is caused by the presence of sodium salts.

3. It has been shown that light produces very little change in color of the oxide and the slight discoloration is only superficial.

4. The magnitude of error has been determined for varying discolorations of tungstic oxide.

THE THEORY OF THE TELEPHONE RECEIVER.

W. H. INGRAM, in *Journal of the Franklyn Institute.*

The equations connecting the winding current and diaphragm motion of a telephone receiver under impressed simple harmonic electromotive and mechanical forces are formulated under: (1) The Maxwell flux theory; (2) the magnetising-winding theory; (3) the Ampèrean resistanceless fixed molecular circuit theory of permanent magnetism; and (4) a general molecular orbital theory of ferromagnetism. On the latter theory it is found that the coupling coefficients M and N in the equations in

* *Amer. Chem. Jour.*, Vol. I., 229 (1879).

question are in general different, in counter-distinction to the other three theories as hitherto formulated. The flux theory is shown not to be inconsistent with this result when certain dynamical phase relations are introduced into the static flux-magnetomotive force formula (Ohm's Law analog) always employed in this theory. The Ampèrean rigid circuit theory is criticised as an inadequate dynamical representation of ferro-magnetism. The magnetising-winding theory (dynamical) is reproduced in slightly generalised form.

THE SYSTEM, WATER AND THE NITRATES OF POTASSIUM AND AMMONIUM AT 25.0°.

By Kinji Ando.

The nitrates of potassium and of ammonium form from their aqueous solutions two series of solid solutions with a gap. As to the extent of the gap no data are found in the literature. Prof. Y. Osaka was in need of those data in the course of one of his investigations. In consequence the writer took up the study of the equilibrium of the system in questian at 25°, and the results of his researches form the present article.

Experimental.

Potassium nitrate of the Pharm. Jp. was thrice recrystallised, and ammonium nitrate (Puriss) or C. Merck twice recrystallised. Ordinary distilled water was used.

The materials in roughly calculated proportions were put in an Erlenmeyer flask of a capacity of about 30 c.c. These salts were completely dissolved by warming and the flask, well stoppered, was made to rotate in a thermostat at 25°. When equilibrium was reached, the solution and residue were separated in the usual way, and the residue was made as free as possible from the mother liquor by pressing between folded filter paper.

Potassium was determined as potassium sulphate and ammonium volumetrically by the familiar methods. Water was calculated by difference.

(Memoirs, College of Chemistry, Tokio University.)

Trade and General Notes.

BOARD OF TRADE ANNOUNCEMENT.

Dyestuffs (Import Regulation) Act, 1920 Applications for Licences in December, 1925.

We are advised by the Board of Trade that the total number of applications received during the month was 571, of which 487 were from merchants or importers. To these should be added 38 cases outstanding on the November 30, making a total for the month of 609. These were dealt with as follows :-

Granted—485 (of which 452 were dealt with within 7 days of receipt).

Referred to British makers of similar products—86 (of which 68 were dealt with within 7 days of receipt).

Referred to Reparation Supplies available—14 (all dealt with within 2 days of receipt).

Outstanding on 31st December, 1925—24.

Of the total of 609 applications received, 534, or 88 per cent. were dealt with within 7 days of receipt.

COMMITTEE ON INDUSTRY AND TRADE.

British Dyestuffs Industry.

At a meeting of the Committee on Industry and Trade, held on Wednesday, January 6, 1926, Dr. E. F. Armstrong, F.R.S., representing the Association of dence regarding the British Dyestuffs Industry. Dr. Armstrong dealt with criticisms of the industry as to the price, range, and quality of its products. He pointed out that criticisms based on a comparison with prices in other countries must take into account the difference between the internal and external purchasing power of depreciated currencies. The witness claimed that on this basis the French user is paying more than two and a half times pre-war prices, which is, generally speaking, the maximum the English user is asked to pay. Dr. Armstrong stated that the same was true of Italy. He gave figures to show that in September, 1925, the average weighted price of the British Dyestuffs Corporation's dyes was 2.35 times the corresponding pre-war price, a ratio which corresponds to the increases in raw materials and labour,

while the ratio for wages and salaries is nearer three.

Dr. Armstrong contended that the statement often made that the high price of dyes is responsible for the diversion abroad of trade in finished goods is shown from official figures to be untrue. He said that the proportion of finished goods in total exports of cotton goods is rising.

He stated that the criticism that this country is dependent on Germany for the finer dyes is incorrect. No vat dyes were made here in 1914, but to-day one firm alone offers 23 compounds in this series, and the number is larger for the industry as a whole. Imports of these colours for six months to June, 1925, were only some 93,000 lbs., while home production was of the order of more than half a million pounds, excluding indigo. The total home production of all colours during this period was over 13 times the amount imported, showing the substantial independence of this country.

ARTIFICIAL SILK.

In few industries is the work of the chemist so definitely demonstrated as in the development of the rapidly expanding artificial silk industry. While its practical utilisation as a successful commercial proposition is of quite recent history, scientists have nibbled at the idea since it was suggested by the French naturalist eamur, in 1742. The suggestion was carried a stage further in 1855, when a Swiss named Andemars patented a process for the manufacture of silk by utilising the natural food of the silkworm for the purpose. Since then investigators have been busy, and while it would be rather bold to say that perfection has been reached, it is obvious that a big stride in that direction has been taken. It is calculated that last year about 100,000,000 lbs. were produced, and the current and future years are certain to witness a great increase in the output and consumption of artificial silk, which has numerous uses.

There are four distinct processes used in its manufacture, viscose, acetate, nitrocellulose, and cuprammonium. The material used is either wood pulp or cotton, and several of the operations to which the raw material is subjected are common to all four processes. The cellulose is dissolved and filtered, spun as a thread and washed and purified. As the field is almost limitless, and the raw materials abundant, there is, without doubt, a great future before this useful invention. While its manufacture is rapidly spreading in both the United States and Canada, and various European countries, England holds the predominant position in the industry. Nuremous companies have recently been formed for its manufacture, but the great firm of Courtauld's, Limited, holds an undisputed position in the industry, and it would not be very wide of the mark to say that this company and its subsidiaries and allies, produced last year about three-fourths of the world's output. The prosperity of Courtauld's is a fitting reward for the brains, genius and enterprise responsible for the organisation of the business, in which science plays an essential part.

AGRICULTURE IN CANADA.

In 1900, Canada had under wheat, 4,225,000 acres, producing 56,000,000 bushels valued at 37,000,000 dollars, whereas last year there was under wheat bushels, valued at 450,000,000 dollars (or approximately £90,000,000.)

Outcrop in 1900, 5,370,000 acres; production 152,000,000 bushels, valued at 52,000,000 dollars. 1925—14,670,000 acres producing 515,000,000 bushels, valued at 206,000,000 dollars.

CANADA—GREATEST PRODUCER OF NICKEL.

The Mond Nickel Company and the International Nickel Company, practically control the nickel industry, amounting in 1924 to about 35,000 short tons, valued close upon 20,000,000 dollars.

PHOTOGRAPHIC MATERIAL FOR EGYPT.

The Ministry of Interior, Egypt, is calling for tenders to be presented by noon on March 16, 1926, for the supply for the year ending March 31, 1927, of various photographic materials.

Local representation is essential.

The conditions of tender, specification, etc., can be inspected by United Kingdom firms interested in the supply of British goods at the offices of the Department of Overseas Trade (Room 53) 35, Old Queen Street, London, S.W.1.

UNITED STATES BUSINESS CONDITIONS.

A cable received by the London office of the *Guaranty Trust Company of New York* reports that brisk holiday trade is the principal feature of the domestic business situation in the United States, but that industry and wholesale trade are seasonably quiet. Cotton exports in November were 1,206,786 bales against 1,421,482 in October and 1,306,550 bales a year ago. Steel ingot production was 3,907,353 tons against 3,893,028 in October and 3,121,149 a year earlier. Unfilled orders of the United States Steel Corporation at the end of last month were 4,581,780 tons against 4,109,183 at the end of the previous month and 4,031,969 tons at the end of November, 1924. Building contracts last month were 464,683,100 dollars, being a seasonal record and 23 per cent. above a year ago. November merchandise amounted to 448 million dollars, and imports to 378 million dollars, against 491 million dollars, and 374 million dollars respectively in October; and 494 million dollars and 296 million dollars in November, 1924. Ocober railroad traffic was the highest on record at 44,061,988,000 net ton miles, or 2.2 per cent. above the previous record, established in October, 1924.

BRITISH ENGINEERING STANDARDS.

The British Engineering Standards Association has recently issued the following British standards specifications:—No. 42 of 1925, Reciprocating Steam Engines for Electrical Purposes; No. 120 of 1925, British Standards specification for Gas Engines for Electrical Purposes; No. 211 of 1925, British Standards specification for Heavy Oil Engines for Electrical Purposes, Diesel Type, Air Injection; No. 212 of 1925, British Standards specification for Heavy Oil Engines for Electrical Purposes, Surface Ignition Type; and No. 213 of 1925, British Standards Specification for Heavy Oil Engines for Electrical Purposes, Airless Injection, Cold-Starting Type.

The specification for Reciprocating Steam Engines is a new edition of the original specification No. 42 issued in 1909. The revision has occupied several years; all the clauses have been modified and brought up to date, and a number of additions have been made. The rating of the steam engine is specified as the load in brake-horse-power assigned to it by the maker to satisfy the requirements of the purchaser and to comply with the specification; a margin of capacity of 25 per cent. above the rated output is called for. The cyclic irregularity has been defined and limits given, and the question of flywheel effect is dealt with. Steam and exhaust pressures, standard speeds, speed adjustments for parelleling and governing, and the equipment which is to form part of the standard engine are also given, together with appendices setting forth the particulars which should be supplied to the engine-maker with the enquiry and the particulars to be supplied by the engine-maker.

The four specifications for gas engines and heavy oil engines were prepared concurrently, and the aim has been to secure consistency and uniformity regarding the salient features as far as practicable. The rating in each case is defined as the load in brake-horse-power, which the engine can carry continuously for a period of 12 hours at its rated speed when working under the stated conditions of pressure and temperature, and in the case of gas engines, with gas of the stated calorific value. The engine must be capable of developing for 1 hour, 10 per cent. above this rating. Clauses have also been included regarding the selection of the size of engine required to suit the capacity of a specified generator; the cyclic irregularity and the question of flywheel; the permissible variation in speed for paralleling and governing; the allowance to be made when an engine is conditions; gas or fuel consumption; tests and standard equipment.

Copies of these Specifications may be obtained from the British 7ngineering Standards Association (Publications Department), 28, Victoria Street, London, S.W.1., or from the publishers, Crosby Lockwood and Sons, 7, Stationers' Hall Court, London, E.C.4., price 1s. 2d. each, post free.

ALGERIA AND TUNIS.

Algeria is an integral part of France, and not a colony in the administrative sense. The country is treated in all matters of administration in exactly the same manner as a French department, and comes under the Ministry of the Interior.

The agricultural wealth of Algeria is principally derived from the cultivation of cereals, and in average years a consider-

able surplus is available for export. The total area under cultivation in 1924 was 7,357,000 acres, and the production amounted to a little over a million metric tons. This compared very unfavourably with the preceding year's crop, which amounted to 2,250,000 metric tons. The reduced output was the immediate result of the drought and of the hot winds.

In order of importance, the culture of the grape-vine comes next after cereals in the economic activity of Algeria. The region of Algiers is the chief centre of wine production, though the vine is cultivated in a number of districts along the coast, covering in all an area of 465,000 acres in 1924, or an increase of about 20,000 acres as compared with the preceding year.

The total value of the general foreign commerce of Algeria in 1924 amounted to 5,540,000,000 francs, while the value of the "special" trade reached 4,784,000,000 frs., a record figure.

Algeria is one of France's best clients. Imports from France in 1924 amounted to 2,224,000,000 frs., and exports to France were 1,475,000,000 frs., whereas the value of the imports from and exports to foreign countries, including French colonies, only reached 570,000,000 frs., and 515,000,000 frs., respectively. During the past year the total imports in the "special" trade were valued at 2,793,744,000 frs., and the exports at 1,990,494,000 frs.

THE INSTITUTE OF METALS.

A Year's Record Growth.

The Institute of Metals increased its membership last year from 1,571 to 1,692. Such progress is remarkable at a time of acute depression in the engineering and metal trades. It indicates that our manufacturers are anxious to avail themselves of the latest scientific knowledge of metals with a view to meeting foreign competition.

A ballot for the election of members and student members of the Institute of Metals will take place on February 24. Persons elected will be entitled to membership advantages for the extended period ending June 30, 1927. Particulars of these advantages, and membership application forms, can be obtained from the Secretary, Mr. G. Shaw Scott, M.Sc., 36-38, Victoria Street, London, S.W.1.

H.M. TRADE COMMISSIONER SERVICE IN SOUTH AFRICA.

The Department of Overseas Trade regrets to announce that Mr. W. G. Wickham, H.M. Senior Trade Commissioner in South Africa, is retiring from that position as from March 27 next, on the grounds of ill-health. The Department wishes to place on record its appreciation of the valuable services rendered by Mr. Wickham as Trade Commissioner in South Africa and New Zealand.

Mr. Wickham will remain on leave until the date of his retirement; in the meantime Mr. N. Elmslie, H.M. Trade Commissioner in New Zealand, who recently concluded an official visit to England, has taken up duty at Johannesburg, as H.M. Acting Senior Trade Commissioner in South Africa, pending the appointment of a successor to Mr. Wickham.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read.

Yesterday afternoon (January 14):—

Effects of Ultra-Violet Radiation upon Involuntary Muscle and the Supposed Physiological Interference of Visible Rays, by Leonard Hill, F.R.S., and Y. Azuma.

The physiological interference is produced by dark heat or visible rays with the exciting action of ultra-violet on involuntary muscle. The action of ultra-violet rays antagonises that of adrenalin on involuntary muscle, but not that of emetin. The presence of calcium in the nturitive fluid is necessary for the increase of tone produced by ultra-violet rays.

A Closed-Circuit Heart-Lung Preparation. Effect of Alterations in the Peripheral Resistance and in the Capacity of the Circulation, by I. de B. Daly. Communicated by Prof. E. H. Starling, F.R.S.

1. A diminution in capacity of the systemic circulation produces the same effects qualitatively and quantitatively as an increase in the volume of circulating blood, namely, a rise in pressure in both auricles, the aorta and the pulmonary artery, and an increase in the cardiac output.

2. An increase in peripheral resistance causes a fall of pressure in both auricles

and in the pulmonary artery, and a diminution in the cardiac output. These changes are due to the raised aortic pressure distending the arterial system, pooling the blood therein, and reducing the inflow to the right heart. The extent of these alterations is dependent upon the "potential capacity increment" possessed by the arterial system.

3. By the simultaneous production of a resistance increase and a capacity diminution, the pressures in the left auricle, right auricle or pulmonary artery, or the output *of the heart can be maintained constant.*

4. When the systemic resistance and capacity of the systemic circulation are balanced so that the output of the heart remains constant, the pulmonary arterial *pressure is unaltered or only slightly* elevated. This is in confirmation of Anrep and Bulatao.

5. "Resistance," "Capacity" and blood distribution effects are interdependent, their relative effects being determined by the physical constants of the circulation.

On the Effect of Insulin on the Dextrose Consumption of Perfused Skeletal Muscle, by C. H. Best. Communicated by Dr. H. H. Dale, Sec., R.S.

Insulin greatly accelerates the rate of sugar disappearance from defibrinated blood used to perfuse the isolated limbs of the cat. The action is attributable to effect on the metabolism of the skeletal muscles.

THE PHYSICAL SOCIETY OF LONDON.

Proceedings at the meeting held on Friday, December 11, 1925, at the Imperial College of Science, F. E. Smith, C.B.E., F.R.S., President, in the chair.

A paper on *The Effect of Rolling on the Crystal Structure of Aluminium*, by E. A. Owen, M.A., D.Sc., and G. D. Preston, B.A., was read by Dr. E. A. Owen.

Abstract.

Sheets of aluminium have been examined by the ionisation spectrometer and by photographic methods, with a view to discriminating between two contradictory results obtained by previous observers with the photographic method as to the final orientation of crystals in rolled material.

The results show that, when a cast specimen of aluminium containing a number of large crystals oriented at random throughout the body of the material is rolled, the crystals break up into a large number of minute crystals. As the thickness of the material is progressively diminished, the small crystals tend to take up a definite orientation, each crystal having a cube diagonal in the direction of rolling and a (211) plane in the plane of rolling. Two sets of crystals exist in the material after rolling, the one set being the optical image of the other in the plane of rolling.

The observations obtained by the ionisation spectrometer indicate that the type of the space lattice remains unaltered, and that the parameter of the material in the severely worked condition does not differ from that of the annealed material by more than 0.5 per cent.

Discussion.

Miss L. Elam discussed the relative merits of the photographic and the ionisation-spectrometer methods. The latter method she considered somewhat unreliable for the present purpose, unless elaborate precautions be taken to move the specimen about both vertical and horizontal axes. If the reflecting planes be not accurately vertical, reflexions may occur which fail to enter the chamber and so pass unnoticed, and in any case the intensity is so much affected by the inclination of the specimen that little importance can be attached to the maximum and minimum values obtained.

Prof. F. H. Hopwood said that both speakers had avoided referring to the amorphous surface layer. Has the assumption that such a layer exists been abandoned?

Dr. E. A. Owen, in reply to the discussion, said that he disagreed with Miss Elam entirely. He considered the spectrometer method much superior, for in the photographic method the plates show reflexions from a number of planes, but there is nothing to show when these reflexions took place or what the orientation of the specimen was. In the spectrometer method as used in the present work, the specimen can be turned np or down as required to get the full effect of the reflected beam. There is the further advantage that all the observavations can be taken at one sitting. However, it is better to work the two methods in conjunction. The work was undertaken on account of discrepancies between the results obtained by two workers who used the

photographic method. No indications of an amorphour layer have been found in these experiments, but they were not very carefully looked for.

A paper on *The Spreading of One Liquid on the Surface of Another*, by R. S. Burdon, B.Sc., Ass.Inst.P., Lecturer in Physics ,University of Adelaide, was read by Mr. Edwin Edser, in the absence of the Author.

Abstract.

The paper gives an account of preliminary investigations into the spreading of liquids on mercury. Water and solutions of a number of inorganic substances are tested.

Purest " conductivity " water in the presence of air is found to spread very slowly on a clean mercury surface; the spreading is greatly accelerated by traces of acid in solution, and totally inhibited by traces of alkali.

All the neutral salts tested, even chlorides of mercury and silver, are found to produce rapid spreading. By varying the concentration of the solution, the rate of spreading is controlled; the phenomena are described, aud photographed.

All acid solutions tested spread rapidly, probably reacting chemically with the mercury. One part of hydrochloric acid in ten million of water definitely accelerates spreading. A drop of very dilute acid spreads rapidly to cover a definite area and stops, any further spreading being as slow as that of water. The area covered during the rapid stage depends on the nature of the acid; it is proportional to the number of acid molecules present, and is larger than would be expected if a monomolecular layer of the appropriate salt were formed on the mercury surface.

Drops of certain alkaline solutions, notably ammonia, are found to spread after a period of delay, the spreading being due to carbon dioxide absorbed from the air.

Electrostatic fields up to 4,000 volts/cm. applied perpendicular to the surface produce no visible results. Placing a platinum wire from one terminal of a battery in the mercury and from the other terminal in the drop, and applying small voltages, causes spreading even in alkalis, if the mercury be positive, and prevents spreading even in dilute acids if the mercury be

Increasing the field beyond that necessary to prevent spreading (mercury negative) sets up an oscillation, the drop spreading till it breaks contact with the terminal, and then contracting . An E.M.F. of 400 volts was required to produce this effect with a drop of conductivity water.

A method of photographing films on the surface of mercury is described. By the same means a photograph is obtained showing a drop of oil spreading on a water surface. The spreading drop is preceded by a well-defined ridge, probably that observed by Osborne Reynolds, but apparently by none of the more recent writers.

The paper concludes with a description of a ridge that may be observed under certain conditions when water is draining from a sheet of perfectly clean glass.

Discussion.

Mr. A. V. Slater: Although Mr. Burdon states in concluding his paper that any theory would be guesswork at the present stage, his paper appears to me to afford several further proofs of already fairly well-known theories. At all events it cannot but be helpful to express such phenomena as are relevant, in terms of existing theories, if only with the object of stimulating discussion.

1. The " distillation theory " of spreading is still further discountenanced by Mr. Burdon's observations that spreading of water is accelerated by traces of acid and inhibited by traces of alkali, which, of course, would not greatly affect spreading by distillation.

2. According to recent work by Rideat and co-workers (Proc. Roy. Soc.), the spreading of a fatty acid on water is due to a pull across the interface and the fatty acid spreads because it, perforce, has to spread. Now, this tension across the interface is explained by molecular attraction between the COOH groups and the water; in Mr. Burdon's case the attraction is between a mercury surface and mercury ions in solution. The extent of the area covered during the *rapid* stage, being proportional to the number of molecules of acid present, is in accord with this theory—the attraction across tbe interface being between mercury atoms in the surface and Hg ions, plus their complement of water of hydration, in the solution. Consequently, the film will be more than a molecule thick and should depend on the extent of hydration of the attracted ion. Any water in excess of that required to hydrate the ions

will spread slowly at the rate for pure water.

3. The advancing ridge observed on spreading may be due to the frictional resistance offered by the surface.

A paper, *On the Advance of the Perihelion of Mercury*, was read by J. T. COMBRIDGE, M.A., M.Sc.

ABSTRACT.

Attention is called to the infinite possibilities of obtaining the Einstein equation for the orbit of a planet by using Newtonian mechanics with an extended potential function. The merits of the other two "crucial phenomena" as such are discussed from this point of view. It is implied that, observational tests being equally satisfied, Einstein's theory is to be preferred on account of its extensive unity and the spontaneity of its results.

DISCUSSION.

Dr. Temple: A curious difficulty arises in connection with equation (12), which is quoted from the paper by Hill and Jefferey. On making $h \rightarrow$ in the Schwarzschild equation (4), we obtain the equation to the curvilinear path of a light pulse (22); but on making $h \rightarrow \infty$ in equation (12), we obtain the equation to a straight line. The solution of this difficulty depends upon an important distinction between the orbital equations obtained from the line-elements due to Schwarzschild and to Hill and Jeffery. The equations of motion derived from both line-elements issue in an equation analogous to Kepler's law of the constancy of areal velocity and in an equation analogous to the Newtonian law of the constancy of the total energy (potential + kinetic). The symbols a and h denote constants of integration figuring in these equations and retaining the same numerical value no matter which line-element is made the basis of our argument. In both cases we may deduce from these two equations a third equation which determines the form of the orbit. But, whereas Schwarzschild's line-element leads to an equation involving only the constant h, the line-element of Hill and Jeffery leads to the equation

$$\frac{d^2u}{d\phi^2} + u = \frac{m}{h^2}(2a^2 - c^2) + \frac{m^2u}{2h^2}(15a^2 - 3c^2) \qquad \text{(A)}$$

which involves both of the constants a and h. (N.B.—Powers of mu higher than the second have been neglected in obtaining equation A.)

In problems of planetary motion we may introduce the approximation—

$$a = c$$

and thus deduce from equation (A) the equation given by Hill and Jeffery and here numbered (12). But in the problem of determining the deviation of rays of light by the sun, not only must we make $h \rightarrow \infty$, but also we must let $a \rightarrow \infty$, while:

$$\frac{h}{a} \rightarrow \text{a finite constant, } \Delta.$$

subsequently to be identified with the perpendicular from the centre of the sun on to the track of the ray of light. We then obtain from equation (A) the relation—

$$\frac{d^2u}{d\phi^2} + u = \frac{2m}{\Delta^2} + \frac{15m^2u}{2\Delta^2}$$

which agrees with equation (22) in yielding the result $4m/\Delta$ for the angular deviation in radians of the light from a distant star.

It is an interesting exercise to deduce equation (A) from the Schwarzschild equation (4) by means of the transformation (11). It may be mentioned that the labour is considerably lightened by identifying not the equations themselves, but their first integrals, namely:—

$$\left(\frac{du}{d\phi}\right)^2 + u^2 = \frac{2m}{h^2}c^2u + 2mu^3 + \frac{a^2 - c^2}{h^2}$$

(Schwarzschild)

and

$$\left(\frac{du}{d\phi}\right)^2 + u^2 = \frac{h^2}{2m}(2a^2 - c^2) + \frac{2h^2}{m^2u^2}(15a^2 - 3c^2) + \frac{a^2 - c^2}{h^2} \text{ (Hill and Jeffrey).}$$

Author's reply: The difficulty mentioned by Dr. Temple had presented itself to me, but I was satisfied that it was purely analy-

tical. The Schwarzschild solution and the Hill and Jeffery solution are merely different pistures of the same field, and I realised that the invisihility of a certain feature in the second canvass was due not to bad painting, but to injudicious hanging, I am grateful to Dr. Temple for so illuminating the scene that the feature in question becomes easily apparent.

The transformation (11) was quoted for transition from (3) to (10).

FARADAY SOCIETY.

Co-ordination and Co-Valency, by J. A. V. BUTLER, M.Sc.

ABSTRACT.

In its original form the theory of valency postulated the mutual satisfaction of combining capacities or valencies, which were supposed to be of the same type and equivalent one to another. Later came the recognition, due to Abegg, that in salt-like compounds valency is definitely polar, *i.e.*, valences which satisfy each other are related as positive to negative. Thus two main types of valency have hitherto been recognised and a considerable measure of agreement as to their nature and the factors determining them, in terms of electronic strncture, has been reached. The main points are summarised below :

1 Electrons in atoms are arranged in a series of groups (or groups of orbits). The inert gases mark the completion of certain stable gronps.

2. Atoms with incomplete groups tend to reach a more stable configuration by interaction with other atoms; they may achieve this either by losing the electrons in the incomplete group or by gaining electrons so as to complete the group.

3 This may occur in two ways, giving rise to the two types of valence :—

(*a*) *Electrovalency.* — The complete transfer of one electron per valence from the atom with excess to that with a deficiency of electrons.

(*b*) *Co-Valency.*—Two atoms, one or both of which have incomplete groups may complete them by mutually sharing electrons. It appears that in most cases a pair of shared electrons constitutes the covalent bond.

It has always been a difficulty to bring inorganic complexes within the general valency scheme. Recently co-ordinated complexes have been regarded as co-valent compounds. The validity of this will be discussed and it will be shown that in their formation a third process is to be distinguished, *i.e.*, the formation of an entire new group of electrons about a stable ion.

SUMMARY.

The nature of the co-ordination bond is discussed. It is shown that the formation of co-ordinated complexes cannot be due in general to the tendency of the central atom to attain the configuration of the next higher inert gas. The electrons contributed by coordinated groups form a distinct group round the central ion. A distinction is drawn between—

(*a*) *Co-valency* : the mutual sharing of electrons by two atoms so as to complete already existent groups, therefore involving negative valences, and

(*b*) *Co-ordination* : the formation of a new group of electrons outside the last group represented in the ion.

It is proposed to use the specific term, "*co-ordination valency*" for the number of co-ordinated groups.

It is assumed that the co-ordination electrons enter the main "quantum group" next to that represented in the central ion. On the basis of the Main, Smith and Stones scheme of division into sub-groups a simple explanation of the Sidgwick rule for the maximum co-ordination valencies exhibited by different elements can be given. The factors which determine the actual co-ordination valencies exhibited are discussed and two are distinguished; (1) the symmetry of the force field of the central ion; (2) a correlation between the co-ordination valency and the electro-valency of the ion.

The constitution of oxy-acids is also discussed from the same point of view.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

PAPERS.

The Council will be glad to receive papers on subjects of interest to the Electrical Industry. These papers may be suitable for discussion at Ordinary Meetings or for publication in the *Journal* without being read at a meeting. The only restriction on the choice of subject is that the paper must

be written with a view to advancing electrical science and engineering. In addition to papers of a strictly electrical character, papers may be submitted on such subjects as phatometry, boilers, lubrication, methods of calculation, engineering economics, legal matters and Government actions affecting the electrical industry, etc. Papers embodying the results of original research and accounts of discoveries and inventions will be particularly welcome, and arrangements will be made for early publication.

Papers (complete with all tables and illustrations) should reach the Secretary not later than May 31 if the authors desire that they should be considered with a view to their being read, if selected, in the first half of the Session (November, December, and January), and not later than October 31 for the second half of the Session (February, March, and April).

PREMIUMS.

All papers accepted by the Council for publication in the *Journal* are eligible for premiums, whether they are read and discussed at a meeting or not.

The following premiums may be awarded for papers adjudged by the Council to be sufficiently meritorious :—

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John Hopkinson	Design and Construction of Electrical Machinery	10
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Wireless Section—		
Duddel	Wireless Telegraphy and High Frequency Engineering	20
Extra Premiums (two)	Wireless Telegraphy and High Frequency Engineering	each 10

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Associates—T. W. Adams, A. T. Green, H. Hunter, D. W. Smith, R. J. Stephenson.

ROYAL INSTITUTION OF GREAT BRITAIN.

THE TRADE OF THE MINER.

It has been the miner's duty to bring to the surface of the earth the minerals of many kinds that lie below it. It is a difficult trade, and often a dangerous one. The history of the attempts that have been made to provide for the safety of the miner is very interesting : on their success depends largely the success of the trade. The first important attempt was made by Humphry Davy, whose safety lamps in their various stages of development are still preserved in the Royal Institution. The old trade, like the others with which the first lectures are concerned, has still an infinity of problems to solve in the light of the knowledge that grows year by year.—*Sir William Bragg, F.R.S.*

NOTICES OF BOOKS.

Principles and Practice of Agricultural Analyses. Third Revised and Enlarged Edition. Vol. I.—*Soils.* Pp. XIV + 686, By HARVEY W. WILEY, A.M., Ph.D. U.S.A : The Chemical Publishing Co., Easton, Pa.

When it is remembered that the land is the main source of the food of man, a work which seeks to increase a knowledge of agriculture, thereby conducing to greater production, deserves practical appreciation. The present volume, which deals practically, scientifically and exhaustively with soils, has met with merited approval, judged by the demand for the first and second editions. The work consists of eight parts : Edaphology, samples of analyses, physical properties of soils, purpose of mechanical analyses, estimation of gases in soils, chemical analysis of soils, activity of nitrifying organisms in the soil, and specal examnation of waters. There are numerous illustrations and a capital index. It is a standard work which will prove very valuable for students, analysts, teachers and practical agriculturists bent on getting the maximum productiveness from the land in return for the capital and labour invested therein.

Manuel du Chimste de Laiterie, Par F. LABARRE. Price, 20 francs. Pp. 168. Gauthuer-Villars & Cie., 55, Quai des *Grands Augustins, Paris.*

FORTHCOMING EVENTS.

ROYAL SOCIETY OF ARTS.

January 18, at 8 p.m., H. P. Shapland, A.R.I.B.A., "*The Decoration of Furniture Moulding.*"

January 20, at 8 p.m. H. Houlston Morgan, Ph.D., B.Sc., F.C.S., President, Oil and Colour Chemists' Association, "Problems in Paint and Varnish Technology." Sir Frank Baines, C.V.O., C.B.E., in the chair.

January 22, at 4.30 p.m. (Indian Section.) Colonel W. M. Coldstream, R.E., C.I.E., "Indian Maps and Surveys." Sir John O. Miller, K.C.S.I., will preside.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

January 21, at 6 p.m. . H. Thompson, M.Sc., and H. Walmsley, "Notes on the *Testing of Static Transformers.*"

Irish Centre, at the Physical Laboratory, Trinity College, Dublin, January 21, at 7.45 p.m. A. B. Trotter, B.A., Faraday Lecture on "Illumination and Light."

Teeside Sub-Centre. January 17, at 7.15 p.m., at the Cleveland Technical Institute, Middlesborough. Informal discussion on "The Isolation and Location and Repairs of Faults," to be opened by Miss E. E. Dunn and W. S. Ramsdale.

THE FARADAY SOCIETY.

Ordinary meeting, Monday, January 18, 1926, at 5.30 p.m., in the Rooms of the Chemical Society, Burlington House, London, W.1.

Papers to be read:—

B. B. Banerji, "The Electrode Capacity and Resistance of Electrolytes for a Wide Range of Frequencies."

J. A. V. Butler, W. E. Hugh, and D. H. Hey, "The Effect of the Electrode Material on Oxidation Potentials."

R. E. W. Maddison, "The Electromotive Behaviour of Cupric Oxide."

A. Highfield, "The Colloidal Properties of Nitrocellulose Sols in Mixed Solvents."

E. P. Perman and T. Lovett, "Vapour Pressure and Heat of Dilution of Aqueous Solutions. Part I."

(a) "Vapour Pressure of Aqueous Solutions of Urea."

(b) "Heat of Dilution of Aqueous Solutions of Urea."

W. Taylor, "A Note on Kinetic Activation as a Factor in Gas Reactions."

ROYAL INSTITUTION.

On Tuesday next, January 19, at 5.15, Professor J. A. Crowther commences a course of two lectures at the Royal Institution on "X-rays and Living Matter." On Thursday, January 21, at the same hour, Professor C. J. Patten will give the first of two lectures on (1) "The Language of Birds"; (2) "The Breeding Factor in Birds"; and on Saturday, January 23, at three o'clock, Mr. Henry Balfour will deliver the first of two lectures on (1) "The Evolution of Coinage"; (2) "The British Coracle."

The Friday evening discourse on January 22 will be delivered by Sir William Bragg on the work of the Davy Faraday Research Laboratory, and on January 29 by Sir William B. Hardy on "Films."

THE INSTITUTE OF METALS.

Papers to be read in March, 1926.

Bailey, R. W.: "Note on the Softening of Strain-Hardened Metals and its Relation to Creep."

Bannister, Professor C. O.: "Note on the Corrosion of an Ancient Tin Specimen."

Crow, T. B.: "Some Experiments on the Soft-Soldering of Copper."

Evans, B. S., and H. F. Richards: "Determination of Zinc Oxide in Brass."

Feitknecht, W. Dr.chem. (Berne, Switzerland): "Crystal Growth in Recrystallised Cold-Worked Metals."

Genders, R.: "The Interpretation of the Macrostructure of Cast Metals."

Hoyt, Samuel L., and T. R. Schermerhorn (Schenectady, N.Y., U.S.A.): "The Hardness of Cold-Rolled Copper."

Hume-Rothery, W.: "Researches on the Nature, Properties and Conditions of Formation of Intermetallic Compounds. I.—V. I The application of the phase rule to systems containing intermetallic or other compounds, and the interpretation of certain points in connection with equilibrium diagrams. II. The nature of intermetallic compounds. III. The nature of metallic phases of variable composition. IV. *The system Calcium-Tin.* V. The system Magnesium-Tin."

Kent, W. L.: "The Brittle Ranges of Bronze."

Lobley, A. Glynne, and Douglas Jepson: "The Influence of Gases on Copper at High Temperatures. Part I."

Mortimer, George: "The Die-Casting of Aluminium Alloys—A Review of Current Methods."

Murphy, A. J.: "The Constitution of the Alloys of Copper and Tin."

Portevin, A. M. (Paris, France): "Striation due to Working or to Corrosion in Microscopical Metallography. A Contribution to the Study of the Mode of Action of Etching Agents."

Stockdale, D.: "The Copper-Rich Aluminium-Copper Alloys."

Tapsell, H. J., and J. Bradley: "The Mechanical Properties at High Temperatures of an Alloy of Nickel and Copper, with Special Reference to Creep."

Report of Council.

MINERALOGICAL SOCIETY.

Tuesday, January 19, at 5.30. Dr. C. E. Tilley, "Some Mineralogical Transformations in Crystalline Schists." Dr. A. Brammall, "Gold and Silver in the Dartmoor Granite." A. H. Hallimond, "On the Chemical Classification of the Mica Group. II. The Basic Micas." G. Greenwood, "The Construction and Use of an X-ray Goniometer."

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Specifications Published.

221,802.—Naamlooze Vennootschap Philips' Gloeilampenfabriken.—Process for separating a mixture of zirconium and hafnium malogenides.

244,167.—Madsenell Corporation.—Means and methods for electrodepositing nickel, cobalt, or nickel alloys.

233,669.—Bemberg Akt.-es. J. P.—Process for the recovery of ammonia from the waste waters in the manufacture of artificial filaments by the cuprammonium process.

235,844.—New Jersey Zinc Co.—Manufacture of zinc oxide.

234,830.—Tartara, G. G. B.—Photographic cameras.

235,864.—Deutsche Gold-Und Silber-Scheideanstalt Vorm Roessler.—Process for the preparation of derivatives of organic arsenical compounds.

240,148.—Millberg, C. — Preparation of pure phosphoric acid starting from natural phosphates.

Abstract Published.

241,771.—Ammonia synthesis. — Harter, H., 8, Theresienstrasse, Wurzburg, Germany, and Otto, A. T., 18, East 41st Street, New York, U.S.A.

In the catalytic synthesis of ammonia, part of the reaction mixture is treated at high pressure (above 400 atmospheres), and the remainder at low pressure (below 400 atmospheres), the products being united for the removal of the ammonia by liquefaction.

242,092.—Phenols.—V. L. Oil Processes, Ltd., Lucas, O. D., and Lomas, E. L., Vickers House, Broadway, Westminster.

Phenols are extracted from crude oils by treating the oils with caustic alkali (usually caustic soda) solution of over 20 per cent. strength so as to form an alkali phenate solution which is used to dissolve further portions of the phenols. The resulting solution is separated from the residual oil and diluted to reduce the concentration of the equivalent content of caustic alkali to below 20 per cent., whereupon the excess phenols separate out. The partly exhausted solution is re-concentrated and again used for treating the crude oils. If caustic soda solutions of over 30 per cent. strength are used, some of the neutral oils pass into solution, but these may be removed by steam distillation before diluting the solution to precipitate the phenols.

The Latest TRADE MARKS

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462,860.—Wood preservative. — Gilbert Gunn, 21, Park Road, Pollokshaws, Glasgow. December 23rd.

SEMSOL.

464,030.—Phosphate fertilisers.—Richardsons Chemical Manure Co., Ltd., 19, Short Strand, Belfast. December 23rd.

HOOFALIZER.

464,180.—Fertilisers. — Norman Tailby, trading as Stonehouse Works Co., Spon Lane Mills, Houghaon St, West Bromwich, Staffordshire. December 23rd.

WALLFORTIS.

464,010.—Chemical Substances used in manufactures, photography, or philosophical research and anti-corrosives.—The Harvis Corporation, Ltd., Broadway Buildings, Broadway, Westminster, S.W.1. December 30, 1925.

GILCORIC.

463,193.—Medicinal Preparations for human use internally.—A Waddington, 5, Bedford Street North, Halifax, Yorkshire.
Halifax, Yorkshire. December 30th, 1925.

TETMAL.

464,106.—Chemical Substances prepared for use in medicine and pharmacy. Tetmal, Ltd., 41, Finsbury Square, London, E.C.2. December 30th, 1925.

ASSIMILOSE.

463,143—Chemical Substances prepared for use in medicine and pharmacy.—Society of Chemical Industry in Basle, 141, to 227, Klybeckstrasse, Basle, Switzerland. December 30th, 1925.

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THE CHEMICAL NEWS.

VOL. CXXXII. No. 3482.

MERTON HOUSE, SALISBURY SQUARE,
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NEXT WEEK—

INDEX DOUBLE NUMBER.

Price 1/-.

THE HYDROLYSIS OF ALUMINIUM SULPHATE—AN APPLICATION OF THE QUINHYDRONE ELECTRODES.

By A. J. PELLING.

(*Extract from the "Journal of the Chemical, Metallurgical and Mining Society of South Africa.*)

During recent years much important work has been done in chemistry with the hydrogen electrode. In its common form, as a piece of platinised platinum surrounded by an atmosphere of pure hydrogen, it can be applied in diverse designs to the simple measurement of hydrogen ion concentrations and in titrations. But, probably owing to magnified difficulties of preparation and manipulation, this form of the hydrogen electrode is not as frequently used in industrial work as it should be, and therefore we might anticipate that a simpler form of apparatus may meet with more favour as a working instrument in this field.

Biilmann has shown that in the measurement of pH values the usual hydrogen electrode may frequently be replaced by a quinhydrone electrode formed by dissolving a small quantity of quinhydrone in the electrolyte concerned and placing a piece of blank platinum in this solution. The quinhydrone then represents a very feeble, but constant, potential pressure of hydrogen.

The theory of this electrode has been fully discussed by Biilmann, Clark, and others. These writers consider the substance quinhydrone* as made up of quinone $C_6H_4O_2$ and hydroquinone $C_6H_4O_2H_2$ in equal molecular proportions, and as dissociating into these constituents in aqueous solution.

If we consider the cell

$$Pt \,|\, \text{Quinhydrone}, \underset{C_1}{[H+]} \,\Big|\, \underset{C_1}{[H+]}, H_2 \text{ 1 atm.} \,|\, Pt$$

Where C_1 represents the normality of a dilute acid electrolyte not exceeding 0.1, the chemical process in the cell will be

$$C_6H_4O_2 + H_2 \rightleftarrows C_6H_4O_2H_2$$

and according to the law of mass action

$$[H_2] = K \frac{[C_6H_4O_2H_2]}{[C_6H_4O_2]} \quad \dots\dots\dots \quad (1)$$

and since the concentration of hydrogen $[H_2]$ is proportional to the hydrogen pressure, P_{hy}, in the solution,

$$P_{hy} = K' \frac{[C_6H_4O_2H_2]}{[C_6H_4O_2]} \quad \dots\dots\dots \quad (2)$$

From Biilmann's measurements (loc. cit.) the hydrogen pressures in solutions of quinhydrone are

$P_{hy} = 10^{-24.4}$ at 18° C.
and $P_{hy} = 10^{-23.64}$ at 25° C.

From equations (1) and (2) we see that since quinhydrone dissociates into equal numbers of molecules of its components in aqueous solutions

$$[C_6H_4O_2H_2] = [C_6H_4O_2]$$

and consequently $[H_2] = K$, and $P_{hy} = K'$. This constancy of P_{hy}, "*independent of the quinhydrone concentration,*" means

* *Quinhydrone may easily be prepared by dissolving equal molecular quantities of quinone and hydroquinone separately in alcohol and then mixing the two solutions. The crystals of quinhydrone which separate out on cooling are washed four or five times with water. Or, hydroquinone is oxidised with ferric ammonium alum according to the principal* $Fe_2O_3 = 2FeO + O$. *Thus, about 25 grms. of hydroquinone in 300 ccs. of warm water, mixed with 100 grms. ferric alum dissolved in 300 ccs. water at about 65° C., precipitates quinhydrone on cooling in ice. It is then washed as above.*

that we can employ the quinhydrone electrode with any concentration of quinhydrone.

Clarke (loc, cit) considers the reaction at the electrode, since hydroquinone is a feeble acid, as

$$\text{Quinone} + 2 \text{ electrons} \rightleftarrows \text{Anion of hydroquinone}$$

$$OC_6H_4O + 2E \rightleftarrows OC_6H_4O$$

and applies Peter's equation for an oxidation-reduction electrode in the form

$$E_h = E_k - \frac{RT}{2F} \ln \frac{[A--]}{[Q]} \quad \ldots \ldots \ldots (3)$$

where E_k is the normal potential of the electrode and E_h the single potential difference at the electrode on the hydrogen standard; [Q] being the total concentration of quinone and [A--] the concentration of the divalent anion of hydroquinone.

The weak acid hydroquinone will have two dissociation constants, namely:

$$\frac{[HA-][H+]}{[H_2A]} = K_1 = 1.1 \times 10^{-10} \ldots (4)$$

and

$$\frac{[A--][H+]}{[HA-]} = K_2 = 10^{-11} \text{ (say)} \ldots (5)$$

Where K_1 = first acid dissociation constant and K_2 = second acid dissociation constant.

Further

$$[HQ] = [H_2A] + [HA] + [A--]$$

where [HQ] = total concentration of hydroquinone.

Solving the above equations for [A--] and substituting the values for K^1 and K_2 we get an equation of the form

$$E_h = E'_k - .000198TpH - .0000992 T\ln \frac{[HQ]}{[Q]} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (6)$$

Vide Clark (loc. cit.).

Thus again we see that if $\frac{[HQ]}{[Q]}$ and the temperature are constant the electrode potential difference E is a linear function of pH within the limits of the assumptions made above. A departure from this relation should begin to appear near pH7, should become marked at pH10, and it should no longer hold at pH11. In general language we may say that as long as the ratio of $\frac{[HQ]}{[Q]}$ is not altered appreciably from unity, as in acid solutions when hydroquinone is practically undissociated, we can use the quinhydrone electrode for the measurement of pH. In *alkaline solutions*, however, dissociation of the hydroquinone resulting from the quinhydrone occurs, and consequently the ratio $\frac{[HQ]}{[Q]}$ alters with the degree of alkalinity, *thereby prohibiting the use of the quinhydrone electrode for accurate measurements in alkaline solutions.*

Thus in acid solutions equation (6) becomes

$$E_h = E'_k - .000198 \text{ TpH} \ldots \ldots \ldots (7)$$

Biilmann determined E'_k in equation (7) by fixing the pH at a known value with definite buffer solutions and measuring the difference of potential between a quinhydrone electrode in these buffer solutions and a hydrogen electrode without quinhydrone in the same buffer solutions. He found

At 18° C. E'_k = .7040.
At 25° C. E'_k = .699.

Influence of Acids and Salts.

Sorensen, Sorensen and Lang discovered that there is a "salt error" with the quinhydrone electrode, which becomes appreciable at salt concentrations of the order of M/5. The quinhydrone electrode in a solution rich in salt is more negative than that of a quinhydrone electrode with a lower salt concentration.

To overcome effects such as these Bülmann and Lund have recommended the use of the *hydro-quinhydrone* electrode, which consists of a polished platinum electrode in contact with the electrolyte, which in this case is *saturated* with, and is in contact with solid hydroquinone and solid quinhydrone. Similarly Biilman and Lund recommend the *quino-quinhydrone* electrode composed of Pt +, electrolyte + solid quinane + solid quinhydrone.

The values for E'_k are at 18° C:—

For hydro-quinhydrone electrode
E'_k = .6180

For quino-quinhydrone electrode
E'_k = .7562

In the quino-quinhydrone electrode we measure the affinity of the transformation

$$2 \text{ mols. quinone (solid)} + H_2 \text{ gas} \rightarrow 1 \text{ mol. quinhydrone (solid)}$$

and in the hydro-quinhydrone electrode the affinity of the reaction

$$1 \text{ mol. quinhydrone (solid)} + H_2 \text{ gas} \rightarrow 2 \text{ mols. hydroquinone (solid)}$$

The Quinhydrone Electrode as a Comparison Electrode.

Stig. Veibel has shown that the quinhydrone electrode with .01 n.HCl + .09 n.KCl buffer solution as electrolyte is a reproducible and very constant standard electrode whose potential is .7040 ± .0002 measured against a hydrogen electrode with the same electrolyte and .2485 ± .0002 volt measured against a 0.1 N calomel electrode. He considers that the reproducibility of this electrode is better than that of the 0.1 N calomel electrode.

The pH of the above buffer solution is 2.04, and its liquid/liquid P.D. is proved to be very small. The potentials quoted above are corrected to pure hydrogen at a pressure of 760 mm. of Hg.

Biilmann and Kararup state that the quinhydrone electrode potential difference is a linear function of the temperature between 0° C. and 37° C. according to the equation

$$E_t = .7175 - .00074t.$$

Applications of the Quinhydrone Electrode.

Bülmann considers that the comparison electrode described by Veibel (loc. cit.) can be used in place of the hydrogen and calomel electrodes as a standard. These electrodes are all in frequent use at the Witwatersrand University, and Veibel's values have always been in agreement with my own observations. To those who have occasion to renew frequently their standard calomel electrodes, the ease and rapidity with which the quinhydrone comparison electrode can be made will readily appeal. It is of great value in routine electrometric work.

Advantages of the Quinhydrone Electrode.

Apart from the advantages outlined above, the quinhydrone electrode can often be used in cases where the hydrogen electrode fails us, as, for instance, in the presence of many reducible compounds, owing to the feeble hydrogen pressure of the quinhydrone.

Biilmann gives many instances of these cases, and states that the electrode can be used over the entire range of pH values which are of practical interest in soil investigations, provided disturbing effects are absent. For other applications the literature index in Biilmann's paper (loc. cit) and in addition Pring can be consulted.

Values of the Quinhydrone Electrode.

Biilmann gives the following values when the quinhydrone electrode is used to measure pH values in conjunction with the 0.1 N calomel electrode at 18° C. :—

For quinhydrone electrode

$$pH = \frac{.3665 - \pi}{.0577}$$

For hydro-quinhydrone electrode

$$pH = \frac{.2800 - \pi}{.0577}$$

and for the case in which the quinhydrone comparison electrode is used against the unknown quinhydrone electrode

$$pH = 2.04 + \frac{\pi}{.0577}$$

where π is the measured E.M.F. in each case.

The Hydrolysis of Aluminium Sulphate.

Denham has investigated the hydrolysis of a number of salts—using the hydrogen electrode. It occurred to the writer that the quinhydrone electrode could be used to this end and that within the limitations outlined above this electrode should offer advantages in industrial work for checking the purity of certain salts. Thus in the case of those salts whose aqueous solutions are acid, due to hydrolysis, or in the case of salts which should be neutral in solution, by determining the actual pH values of their respective solutions an idea of the quantity of acidic impurities should be gained.

The writer has investigated therefore the pH values of solutions of $Al_2(SO_4)_3$, both with the Clark shaking electrode using pure hydrogen and with the quinhydrone electrode. Thus a comparison of the values given by these two electrodes was obtained.

SEALED WATER TROUGH ASH CONVEYING.

One of the most difficult problems in steam and power generation has long been the mechanical conveying of the red hot ash and clinker, which is not only abrasive, but also develops acid very strongly when

sprinkled or quenched with water in the ordinary way. However, the modern sealed water trough conveyor seems to have solved most of the difficulties, and it is a curious fact from the chemical point of view that when ash and clinker at a high temperature is suddenly discharged overhead into water and thereby shivered into fragments, the solution is alkaline. Apparently this is because lime, potassium, and sodium salts are dissolved, much in excess of the acid due to pyrites in the coal, and thus one of the main difficulties is completely eliminated. An excellent example of modern practice sealed water trough ash conveying is the "Usco" equipment at the new Nottingham super-power station. The boiler plant consists of six "Stirling" boilers of a normal evaporative capacity of 55,000 lbs. of water per hour each, fired with three "Class A Underfeed" standard travelling grate stokers, that is, eighteen stokers in all, and the ash handling plant is laid out in the form of two long sealed troughs with stagnant water and drag link conveyors as well as inclined elevators to take the material to overhead ash tank, each which handles the ash and clinker from three boilers, that is to say nine mechanical stokers.

The horizontal troughs are cast iron, having a total length of 137′ 0″, bolted together in sections of 4′ 6″ in length, and supported on short concrete pillars at 9′ 0″ centres so as to life the whole trough 2′ 9″ clear to the ground. The ash and clinker is discharged continuously into each trough from the end of the mechanical stokers throngh cast iron shoots which dip into the water so as to give an absolutely air-tight seal, and the drag link chain conveyor consists of a double chain with links at 1′ 7½″ centres and 8½″ pitch, fitted with cross bars or paddle which are 4½″ deep and spaced apart 2′ 1½″, with extra wide case-hardened blocks. These troughs lead at one end to an inclined drag link conveyor at an angle of 35° constructed of a rolled steel channel frame fitted with cast iron bottom plates, having renewable chain track strips, with a total length in each case of 60 feet discharging to the overhead storage ash tanks which are of 600 cubic feet capacity, railway wagons being backed direct underneath. The driving gear for each het of combined water trough conveyors and inclined elevator is a 5 h.p. motor and the normal chain speed is 10 feet per minute, giving a duty of 2½-3 tons of ash per hour.

This general method, with suitable modifications, is equally applicable to "Lancashire" boilers and over sixty plants are now at work, including the continuous sluice conveyor with water flowing through the trough instead of a chain conveyor, and the intermittent sluice principle having stagnant water swilled out at short intervals.

DIELECTRIC CONSTANTS OF LIQUIDS. PART I.—ON THE METHOD OF MEASURING DIELECTRIC CONSTANTS OF LIQUIDS.

By Yoshikatsu Matsuike.

Among many methods of measuring dielectric constants, the so-called "Resonance Method," it is said, gives the most accurate results.

The present author improved several points in this method, and finally got a nearly perfect apparatus for the measurements.

When a certain potential difference is applied on the plate circuit and some current on the filament of a triod valve in whose plate circuit certain capacity and impedence have been inserted and in whose grid circuit certain impedance has been inserted, there an oscillation current is set up. The frequency of that current is given by the formula,

$$n = 1/2\pi\sqrt{LC}$$

where L is the self-capacity, C the capacity, and n the frequency.

We can, therefore, by changing the value L or C, obtain current of any frequency at will.

If two such circuits with high but nearly equal frequencies are coupled, there occur beats corresponding to the difference between them. But when the capacity C is changed by ΔC in one of the circuits under constant L, n of that circuit will change twice as much as C, that is

$$2\Delta n/n = \Delta C/C$$

and naturally the frequency of the beat changes.

Hence, by adjusting the capacity in one of the coupled circuits, it is possible to have a point of resonance between them where the beat dies.

Now when a cell is inserted parallel to the condenser of one of these circuits, and its medium changed while other conditions are kept constant, the total capacity of this

circuit changes, and its amount can be determined by the displacement of the resonance point or by the change of the number of beats. The dielectric constant of the medium of the cell can be calculated easily from the data of this capacity change.

SUMMARY.

(1) An apparatus for the measurements of dielectric constants of liquids by means of resonance of two high oscillators is described.

(2) Dielectric constants of several liquids are given with the accuracy of about one-thousandth.

In conclusion, the present author wishes to express his grateful thanks to Assistant-Professor Shinroku Mitsukuri, under whose kind guidance and encouragement the present work was carried on, and also to Mr. Mishio Ishimoto of the Mitsubishi Ship Building Co., for his valuable advices.

A part of the expense of this experiment was paid by the research fund granted to Prof. S. Mitsukuri from the Department of Education, and also by the research fund granted to the present author from the Kuzuhara Cold Storage Co. at Tokyo.

(The Laboratory of Theoretical Chemistry.)

SILVER AS A CATALYSER FOR THE ABSORPTION OF ETHYLENE BY MEANS OF SULPHURIC ACID.

(Abstracted from *Berichte*, May, 1924, page 848.)

No. 170. W. Lommel and R. Englehardt.

In part 2 of a report published by W. Gluud and G. Schneider, the discovery is made that silver sulphate is a valuahle accelerator for the reaction between ethylene and sulphuric acid.

The authors have made independently similar observations. The process was announced on September 9, 1921, but patent in Germany in the Chemischen Zentralblatt. The English patent number is 185,757 and the manufacture was published on November 1, 1922.

The problem concerns catalysis in which the action of the catalyzer is comparatively safely known. The process is divided into two parts. Firstly, there is a deposit of the silver salt of ethylene. And secondly, the formation of ethylsulphuric acid. The first reaction proceeds very rapidly at ordinary temperatures, but the second accelerates at a specifically higher temperature of about 40°. Consequently the whole operation is quite satisfactory. One may follow closely, without interruption, the first partial reaction, since it is possible again to separate the ethylene by exhaustion so long as it still shows additive compounds in the silver salt.

This silver-ethylene compound is also formed in aqueous solution in absence of sulphuric acid. For example, dissolve 20 ccs. of a 15% silver nitrate solution in 120 ccs. of ethyene, corresponds to 1/4th of a molecular proportion. This mixture has a fairly high ethyene tension, which, however, owing to the low required acid addition is reduced.

Thus silver sulphate absorbs in 8% sulphuric acid 1 molecule of ethylene. (No definite data is given in this brief extract.)

By employing another acid such as phosphoric, the tension is considerably reduced so that the reaction is serviceable for analytical purposes.

Comparison tests between absorption with silver nitrate solution (10%) in a 4% solution of phosphoric acid and the well-known Hempel bromine method shows the following values for dfferent gaseous mixtures. The bromine value is in brackets :—

7.6(7.6); 4.8(4.8); 5.9(6.0); 0.8(0.9); 0.8(0.8) %.

The reaction in aqueous solution shows the advantage conversely to the reaction with con. sulphuric acid and bromine as, more solution may by exhaustion with the water-pump regenerate in the pipette.

The homologues of ethylene behave similarly.

Trade and General Notes.

BRITISH INDUSTRIES FAIR.

RECORD NUMBER OF BUYERS EXPECTED.

A very large number of Overseas Buyers are expected to visit the forthcoming British Industries Fair to be held at the White City, London, and at Birmingham, in February.

Invitations to may Overseas Buyers were sent out several weeks ago, and replies are now being received by the Department of Overseas Trade. Although many invitations have yet to be issued to buyers in the nearer Continental countries, buyers from Algeria, Egypt, Brazil, Colombit, U.S.A.,

Uruguay, China, Dutch East Indies, Persia, Syria, Australia, British West Indies, Canada, Hong Kong, India, New Zealand, South Africa, Belgium, Czecho-Slovakia, Deumark, Finland, France, Germany, Greece, Holland, Hunary, Italy, Portugal, Spain, Japan, Peru, Costa Rica and Panama have already intimated their intention of visiting the Fair.

During the next few weeks, invitations will also be issued to over 150,000 home buyers.

COLOUR USERS' ASSOCIATION.

From the above comes the vade-mecum for 1926-7. It is vest-pocket size, and neatly prodneed It contains in a small space a vast amount of figures relating to the important dye industry. There are also many pages of statistics of interest to everybody. There is a ready reckoner, metric tables, etc. The size is handy for the vest pocket and it will be found serviceable for ready reference on many occasions during the year or two for which it has been issued.

NEW LEAD MINE IN ONTARIO.

What is said to be a very promising lead property near Arnprior, a short distance from Ottawa, is to be developed by the Ottawa Valley Syndicate, which is using its own money for the purpose. Mr. Ernest Green, who is in charge of the development, states that daily production will soon reach 800 tons. At present the Kingdom mine, at Galetta, is the only lead-producing mine in Ontario. Diamond drilling is said to have been going on for some time in the vicinity of Arnprior, and evidence brought up from the properties tested indicates that at least six splendid mines are in view. In addition to lead in paying quantities, discovery of more than hopeful nature of feldspar, mica, graphite and molybdenum and of gold and silver has been made.

THE LIFE OF THE BATTERIES.

A table published in the current issue of *Popular Radio* indicates the approximate life of a set of " B " batteries with the LC-26 receiver. It will be noted that the " heavy duty " type of batteries give almost double the service of the usual " large " (five-pound) type(although the cost of them is only about 50 per cent. greater. The above figures are based on the use of the total voltage specified (namely, 157½ volts), but takes into consideration the normal drop in voltage as the batteries wear down. When the batteries drop from 45 volts each to 34 volts, they are worn out and should be replaced.

Hours of use daily ...	2 days	3 days	4 days
Large size batteries ...	166	105	72
Heavy duty batteries	297	190	134

—*Popular Radio.*

NEW F.B.I. PRESIDENT-ELECT.—PROMINENT IN CHEMICAL INDUSTRY.

Sir Max Muspratt, Bart., J.P., the President-Elect of the F.B.I., in succession to Col. The Hon. Vernon Willey, is one of the leading figures in the chemical industry, and Chairman of the United Alkali Co., Ltd., which is, in the strictest sense of the word, a family concern. Actually, three years ago there was celebrated the centenary of the alkali ondustry, which was founded by James Muspratt, the grandfather of Sir Max, who thus represents the third generation of his family to hold the Chairmanship of this vast chemical undertaikng, while at the present moment, Sir Max's son has just taken his honours degree in Chemistry at Oxford University.

Sir Max was born in Liverpool in 1872, and is therefore fifty-three years of age. He was educated at Clifton College and at Zurich, entering in 1895 the works of the company of which he is now Chairman. In 1901 he became a director on the technical side of the business, and succeeded his father in the chairmanship in 1914. But Sir Max is not only well known as a busiuess man in the chemical world; he is also himself a chemist of great ability, and is the first Englishman to hold the Diploma in Industrial Chemistry awarded by the Swiss Government.

Few industrialists can have a wider field of activities than the new F.B.I. President-Elect. In addition to the Chairmanship of his own busiuess, he is the Vice-President of the Association of British Chemical Manufacturers; Deputy Chairman of the Sulphuric Acid Association; Chairman of the recently-appointed Lord Mayor of Liverpool's Committee on Trade and Industry of the Port of Liverpool; and Chairman of the Liverpood Economic League. He has taken a very active part in Liberal politics on Mersey-side, and was M.P. for the Exchange Division of Liverpood in 1910.

GASES IN METALS: II. THE DETERMINATION OF OXYGEN AND HYDROGEN IN METALS BY FUSION IN VACUUM.

By Louis Jordan and James R. Eckman.

(*U.S.A. Bureau of Standards.*)

Abstract.

Nearly all metals contain small amounts of oxygen, hydrogen, and nitrogen, frequently spoken of as "gases in metals," whether or not they exist as oxides, hydrides, and nitrides or in some other form. Many differences in quality of metals not readily attributed to differences in composition, as determined by the usual chemical analyses, or to different physical treatments are supposed to be due to the presence of "gases" in the metals.

Satisfactory and generally applicable methods for determining oxygen in metals have not been available. Experimental studies were made of methods of fusion employed in previous vacuum fusion methods. Direct fusion of low-carbon iron alloys in refractory-oxide crucibles, or fusion with antimony tin in similar crucibles, does not determine all of the oxygen present in the metal. In the first case there is the additional difficulty of reduction of the refractory oxides by the carbon in the steel. In the fusion of high-carbon iron alloys this reaction between refractory oxides and carbon of the metal is very pronounced in direct fusion of the metal and is sufficient, even in fusion with antimony tin, to give values for oxygen in excess of the true oxygen content of the metal. Fusion of the metal sample in a graphite crucible permits satisfactory determination of oxygen in both low-carbon and high-carbon alloys.

A new vacuum fusion procedure for the determination of oxygen and hydrogen in metals was developed. A sample of metal of from 20 to 60 g., which may be a single solid piece thus avoiding difficulty from surface oxidation of chips, is fused in a gas-free graphite crucible in vacuum. The water vapour, carbon dioxide, carbon monoxide and hydrogen evolved during the heating and fusion of the sample are absorbed in suitable solid absorbents and determined by the increase in weight of the absorbent tubes. Total oxygen and hydrogen in the sample can then be calculated. The method does not distinguish between oxygen present in the metal as CO, CO_2, oxides of non-metallic inclusions or of metallic constituents. Under the conditions of this analysis the recovery of oxygen from the oxides of iron, manganese, silicon, aluminium, titanium, and zirconium is complete. The presence of sulphur in the iron or steel sample does not interfere with the determination of oxygen by this method. The method is applicable to the accurate determination of oxygen in pure iron, steels, cast irons, and pig irons, and also in many non-ferrous metals and alloys.

Summary.

1. A train of solid absorbents was developed suitable for the direct determination of water vapour and carbon dioxide and for the indirect determination of carbon monoxide and hydrogen when these gases were passing through the train at low pressures. By means of this train one or all of these gases present in the mixture of gases evolved from a metal sample fused in vacuum may be accurately determined.

2. The high-frequency induction furnace was used for the fusion of the metal samples. This type of furnace permits the fusion of the samples in a small silica tube and holding the metal molten at temperatures of 1,500° C., or more while the walls of the tube remain comparatively cool. Thus, no difficulty is encountered from the failure of the tube to hold a vacuum.

3. Three methods of fusion previously employed in the determination of gases in metals fused in vacuum were applied to pure iron, a low-carbon steel, and a high-carbon steel. These methods were (a) direct fusion of the metal in a refractory oxide crucible, (b) fusion in a refractory oxide crucible with the addition of antimony and tin, and (c) fusion in a gas-free graphite crucible. Neither (a) nor (b) is satisfactory for determining oxygen in ferrous alloys. Method (c) gives the most dependable values for total oxygen. The values obtained for hydrogen offer no choice between the three methods for the determination of this element.

4. Fusion of ferrous alloys in graphite determines, besides any oxygen present as such, the oxygen that may be present in the metal as CO, CO_2 and oxides of iron, silicon, manganese, aluminium, zirconium, and titanium. The sulphur in the iron or steel sample does not interfere with the determination of oxygen.

5. The fusion in graphite method is also applicable to the determination of oxygen

and hydrogen in many non-ferrous metals and alloys.

The authors wish to acknowledge the assistance of several of their associates in the division of metallurgy of the Bureau of Standards. They are especially indebted to J. R. Cain for aid in the initiation and earlier portions of this work, to W. P. Barrows for many test analyses of the method as finally developed, and to R. J. Kranaues for faithful and painstaking aid in the preparation of samples, crucibles, and insulators, and in the care of absorption tubes.

UNITED STATES BUREAU OF STANDARDS—ANNUAL REPORT.

The annual report of the Director of the Bureau of Standards for the fiscal year ended June 30, 1925, is a record of a full year's work of great interest and importance to both the public at large and to science (which means virtually the same thing).

Functions and Organisation.

The general function of the Bureau is the development, construction, custody, and maintenance of reference and working standards used in industry and commerce. Standards are divided into five classes, and the work necessarily covers a very wide field. As a matter of convenience the organisation of the bureau is based not on classes of standards, but upon the nature of the work. Thus, experts in electricity are grouped in one division, while those dealing with optics form another major division.

There are 11 scientific and technical divisions besides the office, operation, and construction divisions. Each of these major divisions is made up of several sections, which deal with a definite class of problems.

The following are a few of the year's achievements of the Weights and Measures Division (of which H. W. and F. S. Holbrook are co-chiefs), and we hope, in subsequent issues, to touch upon the work of the other ten divisions.

Dental Research.—An investigation of precious metal dental alloys is in progress to improve the quality and permanence of dental restorations by a wiser choice of materials and by the selection of the most apropriate mechanical manipulation and heat treatment. Two papers rescribing the results so far obtained appeared in the Journal of the American Dental Association for May, 1925.

New Apparatus for Testing Hæmacytometer Chambers.—A new instrument based upon the principle of the interference of light waves was designed and constructed for use in testing hæmacytometers (blood corpuscle counting chambers). The instrument has been given a thorough test, and the results show that it is from five to ten times more accurate than the micrometer apparatus formerly employed. Furthermore, the time required to complete the same amount of work with the new instrument is from one-fourth to one-fifth that previously required.

Graduation and Test of Invar Tapes. During the past year a large number of invar tapes, such as are used by the United States Coast and Geodetic Survey, were standardised at the Bureau, and about 25 were also graduated. The graduations were placed on the tapes with such precision that the actual error in the total length of the tapes was in many cases less than 1 part in 1,000,000. In the standardisation of these tapes the length values obtained were accurate to 1 part in from 5,000,000 to 10,000,000. The repeated standardisation of several tapes of different ages showed that tapes made from 10 to 15 years ago are practically constant in length, while in the case of invar manufactured within the past few years, lack of dimensional stability is a source of some uncertainty.

Scales Used for Weighing Grain.—Included among the scales mentioned above were 82 track scales used for weighing grain. Of these 35, or 42.7 per cent., passed the special grain-scale tolerance, namely, 0.10 per cent. of the applied load. Corrective adjustments were made on 20 of the 47 scales that failed to comply with this tolerance.

Improvement in Graduated Glassware.—Of the 10,000 pieces of graduated glassware submitted for test during the year, 87 per cent. passed the test and received the precision stamp of the Bureau.

Electricity.

(E. C. Crittenden, Chief.)

Measurement of High Voltages and Large Currents.—The extension of accurate measurements to keep pace with development in power transmission has taxed the resources of the bureau. By refining the

methods previously used, the calibration of voltage transformers is being carried up to 100,000 volts. An absolute electrometer which will measure up to 350,000 volts is now ready for assembly. Accurate tests of resistance standards used for measurement of current have been extended to 10,000 amperes on direct current, and tubular oil-cooled standards for tests of current transformers at 5,000 amperes have been designed.

Electrical Insulating Materials.—Special attention has been given to the possible development of ruber compounds suitable for submarine-cable insulation, and some have been found which are better than gutta-percha in electrical properties. To simulate deep-sea conditions, apparatus has been installed for making electrical measurements on wires under pressures up to 10,000 pounds per square inch.

Battery Investigations. — Dry cells, storage batteries, and caustic soda primary batteries used for railway signalling have all received much attention during the year. The performance of all the important types of railway batteries has been determined, both at ordinary temperatures and at the freezing point, as a basis for specifications in preparation jointly by the American Railway Association, the battery manufacturers and the bureau.

Lamps and Lighting.—During the year over 1,500,000 electric lamps purchased by the Government were inspected by the Bureau; 3,194 samples were put through a life test to determine whether the lamps supplied were acceptable and to obtain data necessary for revision of the standard specifications.

Radio Communication. — Methods of making more accurate measurements of frequency and means for getting these measurements into actual use have been the most important tasks in this field. Accuracy was materially improved by using a simple harmonic amplifier to step up from audio to radio frequencies and by stepping down from very high frequencies for which the wave lengths were measured directly on a parallel wire system. Standard frequency signals covering the range from 125 to 6,000 kilocycles were transmitted from the bureau and from Leland Stanford University at advertised times, measurements on many stations were made at the bureau, frequency indicators were calibrated for high-grade stations, and lists of standard frequency stations were published periodically.

Electrolysis and Soil Corrosion of Metals. —A technologic paper has been prepared summarising the Bureau's conclusions on methods of testing to determine when damage is occurring by electrolysis. This represents the results of many years' work in field surveys, and several months have been spent in discussions with representatives of the different utility interests involved in order to make this paper accord with their experience in so far as is possible. A progress report covering the first sets of corosion samples (iron pipe) dug up from different soils has been issued through the American Foundrymen's Association. The samples have been carefully studied by many manufacturers and users of pipe.

Magnetic Testing of Wire Rope.—Since magnetic measurements seem to promise the only practicable method of testing steel rope in service, efforts have been continued to avoid the difficulties which have hitherto prevented the actual use of this apparently simple method.

Heat and Power.

(H. C. Dickinson, chief.)

Phenomena of Combustion.—A systematic study of explosive gaseous reactions has led to the discovery of a relation between composition of the explosive mixtures and velocity of flame propagation, which is new and important both theoretically and practically.

Steam Table Research.—This work is being carried out with the co-operation of the American Society of Mechanical Engineers for the purpose of providing more accurate tables of the properties of water and steam, particularly in the range of high pressures which are of increasing technical importance.

Standardising of Seger Cones.—Seger cones are used throughout the ceramic industries to gauge the firing of kilns and to indicate the maturing of clay ware. There is an insistent appeal from ceramists for adequate standardisation of Seger cones. The standardisation in progress involves not only temperature measurements, but accurate control of rate of temperature rise and of the gaseous atmosphere surrounding the cones. The work is well advanced, and results will be available to the ceramic industry in the next few months.

Aviation Engine Tests.—In anticipation of an increasing demand for tests of aviation engines, the possibilities of an aptor and at the exhaust port were reduced

proximate type of altitude test which would require less extensive equipment than is available at the Bureau of Standards have been investigated. An engine, which had just received a very complete performance test in the altitude chamber ,was employed. Pressures at the entrance to the carburetas in an altitute chamber test, but the air surrounding the engine was allowed to remain at sea level pressure. Satisfactory results were obtained.

Non-flammable Liquids for Cryostats.—The use in many laboratories of volatile flammable liquids in low-temperature comparison baths has led to serious accidents and loss of life. A systematic study of the possibility of replacing such dangerous liquids has led to the development of non-flammable mixtures which can be used at temperatures down to −150° C., and being liquid at ordinary temperatures and pressures, may be kept in bottles.

Heat Transfer Through Building Materials.—There has been a striking increase in the demand for information regarding problems of heat transfer. A satisfactory laboratory method of measurement of heat transfer through moderate sized panels has been developed. Tests covering a considerable range of temperature have been completed on eight typical wall constructions widely used in small buildings. Further tests are in progress, and additional panels are being built. Results already obtained will soon be published.

Co-operative Fuel Research.—In co-operation with the American Petroleum Institute, National Automobile Chamber of Commerce, and the Society of Automotive Engineers, a study of the factors affecting crank-case oil dilution and engine starting has been made. The study of dilution is practically completed. It has shown that dilution depends primarily upon the average temperature of the cylinder walls, the volatility of the fuel, and the average fuel-air ratio. Thus, a basis is furnished for improvement of engine design and operation.

In the investigation of starting, the influence of many factors has been examined. These include fuel-air ratio, jet size, jet location, spark advance, fuel volatility, amount of throttling, amount of choking, temperature of jacket water, and tempera-
Strength of Materials at High Tempera-
ture of entering air.

Strength of Materials at High Temperatures.—Work was resumed on compression tests of rolled structural steel and cast-iron shapes at temperatures from 100° to 900° C. A rise in the compressive strength comparable with what has been found in tension tests in the region 200° to 300° C. obtained only for heavy or symmetrical shapes. Sensitiveness and accuracy of load temperature and deformation measurements were attained sufficient to give conclusive information on strength and deformation within the temperature and loading ranges of interest in connection with the fire resistance of steel and cast-iron building members.

Platinum Resistance Thermometry at Low Temperatures.—By the development of a modification of the Callendar formula, used in platinum resistance thermometry above 0° C., the maintenance of a standard scale of temperature in the range 0° to −190° C., has been made as simple and certain as has been the case for temperatures above 0° C. The modified equation requires only a single calibration point at low temperature, in addition to the customary calibration at 0° and above. Test of the equation was made by applying it to the available data, and indications are that it reproduces the latter within their own limits of accuracy.

(*To be Continued.*)

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL SOCIETY.

Papers read in title only. January 14.

Experimental Studies on the Differentiation of Embryonic Tissues Growing in vivo *and* in vitro. *I. The Development of the Undifferentiated Limb-bud* (a) *when Subcutaneously Grafted into the Post-Embryonic Chick, and* (b) *when Cultivated in vitro.* By T. S. P. Strangeways and Honor B. Fell. Communicated by Sir William Hardy, Sec., R.S.

Muscular Exercise, Lactic Acid, and the Supply and Utilisation of Oxygen. Part XIV.—The Relation in Man Between the Oxygen Intake during Exercise and the Lactic Acid Content of the Muscles. By C N. Long. Communicated by Prof. A. V Hill, F.R.S.

(1) Experiments have been performed on men to test the validity of the relatio

found to exist, by Hartree and Hill, in the case of the isolated muscle, between the speed of the oxidative removal of lactic acid in recovery and its concentration in the muscle at the same time.

(2) In men, as well as in the isolated muscle, it has been found that the rate of removal of lactic acid, as measured by the oxygen intake, is proportional to the square of the lactic acid concentration in the fluids which are in contact with the muscle fibres.

(3) Lactic acid apparently acts as a "governor of oxidation" in the recovery process of muscle.

The Metabolism of the Diabetic Individual during and after Muscular Exercise. By K. F. Hetzel and C. N. Long. Communicated by Prof. A. V. Hill, F.R.S.

1. Muscular exercise in the diabetic individual appears to be accompanied by the same metabolic changes as in the normal. The curves of recovery oxygen intake and of carbon dioxide output are similar to those of normal men, both for mild and for more strenuous exertion. The increase in lactic acid in the blood attained values as high as in normal men performing similar exercise. There is no unusual delay in the time required for the removal of this lactic acid.

2. Exercise increases the combustion of carbohydrate in the diabetic. For short periods of exercise ,with insulin administered during the last 17 hours, the respiratory quotient of the excess metabolism is unity, exactly as in normal men; for exercise of moderate duration the value of the respiratory quotient of the excess metabolism is intermediate, while for exercise of long duration it tends to fall towards that of the previous resting metabolism. In this respect the diabetic individual with recent insulin, on a diet poor in carbohydrate, behaves in a manner exactly similar to a normal man on a diet consisting mainly of fat. The phenomena, however, are even more exaggerated than in such a normal individual.

3. In a diabetic individual without insulin for lon gperiods the respiratory quotient of the excess metabolism is low, even for short periods of exercise.

4. The simplest way of regarding the matter is to suppose that a muscle, for its oxidative processes in recovery from exertion, uses carbohydrate only; that in the presence of insulin there are stores of carbohydrate in a form readily available for use by the muscle, and that a short interval of exercise does not sufficiently deplete these stores to render an immediate restoration necessary from other substances in the body. In the absence, however, of insulin, these ready stores of carbohydrate have run low, so that exercise even of the shortest duration stimulates the metabolic processes of the body to restore the reserves of carbohydrate. In this respect three factors, (i) prolonged muscular exertion, (ii) a diet poor in carbohydrate, and (iii) the absence of insulin, produce the same effect, namely, a lowering of the respiratory quotient of the excess metabolism due to exercise. All these factors might be expected to deplete the stores of carbohydrate readily available.

The Diffraction Method of Measuring the Diameter of Erythrocytes. By W. G. Millar. Communicated by Sir E. Sharpey Schafer, F.R.S.

THE PHOTOLYSIS OF METHYLENE BLUE, SENSITISED BY ZINC OXIDE.

By Emil Baur.

Faraday Society, October 1 and 2, 1925.

It was thought formerly that a light-absorbing substance takes up radiant energy continuously throughout the whole mass. On this view the facts of photochemical sensitisation could not easily be understood. An explanation was first made possible on the theory of quanta. This theory requires that at every moment the absorbed energy is accumulated on a few molecules. The molecule is supposed to take up only whole quanta, $h\nu$. The state acquired by the molecule in the light differs from the state in the dark by a discrete unit. As we call the discontinuous changes of matter chemical processes, we may consider a molecule that has absorbed a quantum as a new chemical substance. In fact, light produces an isomerisation. Let us call this kind of isomer a "phototrope."

A quantum of energy of visible light being relatively great, the phototrope should be considered as a substance very unstable and chemically very active. Therefore we may easlly imagine that it can react with other substances. If it returns thereby into its original state in the dark, we have *the reaction-type of photochemical sensitisation.* The energy transferred to the sensitised substance will decompose the latter, as happens, for instance, with brom-

ide of silver in an orthochromatic plate and with carbonic acid in grains of chlorophyl.

We must examine the process of transport of energy in more detail, if we are to enter more closely into the behaviour of photolysis.

Some recent investigations on the Becquerel effect have shown that the phototrope behaves as if it were split up into a lower and in a higher oxidised part. When the phototrope decomposes another substance in its neighbourhood, the latter is oxidised by one half and reduced by the other, similarly to electrolysis. Hence it was to be deduced, that the photo-chemical sensitiser works to some extent like anode and kathode.

According to the Bohr theory, this behaviour is easily understood. If a quantum of radiant energy is absorbed, an electron jumps to a higher orbit. Instead of falling down to the former orbit, it will be able to neutralise another positive ion, while the positive body of the phototrope will restore the state in the dark by extracting an electron from another negative ion. These two processes are just the same as the processes at the cathode and the anode in ordinary electrolysis. Therefore we can state that photolysis is a molecular electrolysis.

This view will be the more acceptible, the more closely photolysis can be imitated by electrolysis, and *vice-versa*.

Acetic acid may be mentioned as a striking example. Sentised by uranyl ion this acid is decomposed either to $C_2H_6 + 2CO_2$ or to $CH_4 + CO_2$. On the other side we usually get by electrolysis $C_{26} + 2CO_2$; but on applying alternating current, $CH_4 + CO_2$ is formed. It is a likely assumption that in both cases acetyl peroxide arises as an intermediate product, which dissociates alone according to the equation:

$$(CH_3COO)_2 = C_2H_6 + 2CO_2$$

and with electrolytic hydrogen according to the equation:

$$(CH_3COOO)_2 + 2H = 2CH_4 + 2CO_2.$$

Representing the phototrope of uranyl by the symbol:

$$U^{vi}\begin{cases} \oplus \\ \ominus \end{cases}$$

the photolysis may be described as follows:

(*a*) in the case of production of ethane,

$$U^{vi}\begin{cases} \oplus + CH_3COO' = CH_3COO = \tfrac{1}{2}C_2H_6 + CO_2 \\ \ominus + \tfrac{1}{2}U^{vi} = \tfrac{1}{2}U^{iv} \end{cases}$$

(*b*) in the case of production of methane,

$$U^{vi}\begin{cases} \oplus + CH_3COO' = CH_3COO \\ \ominus + H + CH_3COO = CH_4 + CO_2 \end{cases}$$

It will be seen that in this example photolysis and electrolysis are in complete accordance with each other.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

Paper read on January 12, 1926.

The Vapour Pressures of Fuel Mixtures: Part II. By J. STANLEY LEWIS, B.Sc. (Wales), A.I.C.

In a paper on "The Vapour Pressures of Binary and Ternary Fuel Mixtures," read before the Institution of Petroleum Technologists (*vide Jour. Pet Tech.*, XI., 49, 1925), a method was described briefly for determining the vapour pressures of mixtures, and reference was made to the vapour pressures of solutions of the various types of hydrocarbons. The present work is a continuation of the above, special attention being paid to the influence of alcohol, the utilisation of which in fuel mixtures is more than a theoretical possibility. The addition of alcohol to hydrocarbons gives rise to mixtures of maximum vapour pressures or minimum boiling points, and in order to make comparative tests the solutions of pure alcohol and (*a*) Hexane C_6H_{14} (paraffin); (*b*) Cyclohexane C_6H_{12} (naphthene); (*c*) Benzene C_6H_6 (aromatic) were studied.

As previously mentioned, the vapour pressure of any one of these hydrocarbons is raised by the addition of alcohol, and also the vapour pressure of alcohol is raised by the solution of the hydrocarbon until a maximum vapour pressure is reached at a particular concentration which varies slightly with the temperature. The three possible binary salutions will be:—

i. Alcohol-Benzene.
ii. Alcohol-Cyclohexane.
iii. Alcohol-Hexane.

Vapour pressure-composition isothermals have been drawn for these mixtures. They indicate clearly the great rise in vapour pressure, and also the fact that only a very small percentage of alcohol serves to raise the vapour pressure of the mixture almost up to the maximum point. A comparison of these figures reveals that the maximum vapour pressure obtainable in any of these binary mixtures is greatest in the case of

lcohol-hexane, which was to be expected rom the higher starting-point vapour pres- nore marked effect than benzene, although ure of hexane, whilst cyclo-hexane has a ne vapour pressures at corresponding tem- eratures and boiling points of these two ompounds are almost identical.

In the cases studied it has been found hat alcohol raises the vapour pressures of ll series of hydrocarbons, the effect being reatest with the paraffins and least with ne benzene series. The rise is enhanced y the presence of water in the alcohol, but o great a concentration of water produces eterogeneous systems. With 98's alcohol the hydrocarbons are miscible in all propor- tions ,but with 95's alcohol, complete solu- bility at ordinary temperatures is attained only when the proportion of alcohol present is relatively large (see former paper), and as the water proportion increases so does the amount of alcohol necessary for pro- ducing a homogeneous solution It will be the aim of a future paper to correlate these variations in vapour pressures of mixtures with the changes in volumes and specific gravities.

In conclusion, a table is appended (Table VI.) giving the boiling points and compositions of all the possible minimum boilng point solutions—binary, ternary, and quaternary.

Constant Boiling Point Mixtures at 760 m.m.

Mixture	B.-pt. ° C.	% Composition Alcohol	Benzene	Cyclo-hexane	Water
Alcohol-benzene	68.25	32.41	67.59	—	—
Alcohol-cyclohexane	64.75	32.20	—	67.80	—
Alcohol-water	78.15	95.57	—	—	4.43
Benzene-cyclohexane	77.80	—	32.3	67.7	—
*Benzene-water	69.25	—	91.17	—	8.83
*Clcyohexane-water	69.30	—	—	91.78	8.22
*Alcohol-benzene-water	64.85	18.5	74.1	—	7.4
*Alcohol-cyclohexane-water ...	62.40	20.4	—	73.8	5.8
Alcohol-benzene-cyclohexane ...	62.25	33.5	29.5	37.0	—
*Cyclohexane-benzene-water ...	67.80	—	29.6	63.0	7.4
*Alcohol-benzene-cyclohexane-water	61.95	19.8	23.1	52.1	5.0

It will be seen that the boiling points are owered as the number of components is aised, until finally the quaternary mixture reached with the lowest boiling point of ll. This is an example of a rarely recorded ixture, namely, a quaternary mixture of onstant boiling point. The distillates arked with an asterisk are not completely iscible at room temperatures but separate ito two phases.

NOTICES OF BOOKS.

A Manual of Organic Chemistry, by rthur P. Luff, M.D., B.Sc., etc., and ugh C. H. Candy, B.Sc., F.I.C., etc. p. 268. London: Cassel & Co., Ltd. rice 6s. net.

The authors are to be congratulated on riting a useful scientific work which will rove useful to large numbers of students nd others, and will be all the more popular ecause of its convenient size, which fits omfortably into the coat pocket. The rst chapters are devoted to general princi- ples, then follow chapters dealing with the analysis of organic compounds, classifica- tion of organic compounds, hydrocarbons, alcohols, aldehydes, aromatic compounds, aldehydes and ketones, alkaloids and other substances of medicinal interest, etc. There are several illustrations.

The Laboratory Book of Mineral Oil Testing, by J. H. Hicks. Fourth Edition, revised by A. W. Cox. Pp. 128, with num- erous illustrations. Cloth, 5s. net. London: Choreless Griffin and Co., Ltd., 42, Drury Lane, W.C.

Oil is a commodity of such commercial importance that too much cannot be known about it—its specific gravity, its flash-point, viscosity, colour, etc., and all these are clearly explained by the author. The details of the various tests are rendered more interesting because of the illustrations with which the work is plentifully supplied. It is compact in size and the price is moderate.

FORTHCOMING EVENTS.

ROYAL SOCIETY.

Thursday, January 28.

INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

EXAMINATIONS IN 1926.

Dates of Examinations—

April 19 to 24, 1926; or April 26 to May 1, 1926. Entries close Monday, February 15, 1926.

September 20 to 25, 1926; or September 27 to October 2, 1926. Entries close Monday, July 19, 1926.

(Examinations were also held on January 4 and 9, 1926.)

Candidates for the Associateship will be examined in January, April and September, and candidates for the Fellowship in April and September only.

THE OPTICAL SOCIETY.

ANNUAL GENERAL MEETING.

The annual general meeting of the Society for the presentation of reports and the election of Officers and Members of Council for the session 1926-27, will be held on Thursday, February 11, 1926.

ROYAL INSTITUTION.

Saturday, January 23, at 21, Albermarle Street, at 3 p.m. "The Evolution of Currency and Coinage," by Mr. H. Balfour.

Friday, January 22, Sir William Bragg, D.Sc., etc., "The Work of the Davy Faraday Research Laboratory."

Thursday, January 28. "The Breeding Factor in Birds," by Charles J. Patten, M.A.

Friday, January 29. Sir William B. Hardy, Sec., R.S., "On Films."

Saturday, January 30. "British Coracle," by Henry Balfour, M.A.

ROYAL SOCIETY OF ARTS.

Monday, February 1. Third Cantor Lecture. "Lacquering," by Mr. H. P. Shapland, A.R.I.B.A.

GEOLOGICAL SOCIETY OF LONDON.

At the meeting on February 3, 1926, Prof. S. J. Shand, D.Sc., F.G.S., will deliver a lecture on "The Alkaline Rocks and Ring Intrusions of Pilansberg (Transvaal)." The lecture will be illustrated by specimens and lantern-slides, and will be followed by a discussion.

At the meeting on February 24, 1926, the following communication will be read:—"The Geological Structure of Ben Lawers and Meall Corrauaich (Perthshire)," by Miss G. L. Elles, D.Sc., F.G.S.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

ANNUAL DINNER AND REUNION.

The Annual Dinner and Reunion of the Institution will be held at the Hotel Cecil, Strand, W.C., on Thursday, 11th February, 1926, at 7.30 p.m., under the Presidency of Mr. R. A. Chattock, supported by the Council.

The charge is 12s. 6d. for each cover, exclusive of wine. Applications for tickets should be made by Saturday, February 6.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

44.—Siegel, W. — Manufacture of sodium fluoride from silico-hydro fluoric acid. January 1st.

32,508.—Andrich, K.—Production of concentrated solutions of alkali cyanides. December 23rd.

32,438.—Bahr, H.—Process for converting sulphuretted hydrogen into sulphurous acid. December 23rd.

32,371.—Schmidt, E. — Production of chlorine and sulphate from alkali chlorides. December 22nd.

Specifications Published.

244,506.—Higgins, E. B.—Treatment of neutral base exchange zeolite-like materials.

238,649.—Naugatuck Chemical Co.—Manufacture of polymerised styrol and its homologues.

244,526.—Harris, H.—Treatment of solutions containing alkali oxysalt o tin.

244,645.—Badische Anilin & Soda Fabrik —Manufacture and production o stable-bicarbonate of ammonium.

Abstract Published.

242,521.—Crotonaldehyde, aldol, butyl

aldehyde, butyl alcohol.—Carbide & Carbou Chemicals Corporation, 30, East 42nd Street, New York, U.S.A.

Crotonaldehyde is made by subjecting aldol, or a material containing aldol, to a temperature not exceeding about 165° C. in an inert atmosphere. The process may be made continuous by feeding a steady stream of aldol into the reaction chamber and removing the decomposition products in a current of nitrogen ,steam or other inert gas. The crude crotonaldehyde obtained may be purified by fractionating in an inert atmosphere and used for the production of pure butyraldehyde and butyl alcohol by hydrogenation. The aldol nsed in the reaction should be made and stored in an atmosphere of nitrogen, acetylene or other non-oxidising gas.

The Latest TRADE MARKS

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KIFLU.

64,445.—Chemical substances used in manufacturers, photography, or philosophical research and anti-corrosives.—Meyhofer and Scharpf Aktiengesellschaft, Goethestrasse, 10, Zurich, Switzerland. January 6th ,1926.

HOLMSPA.

459,359.—A medicinal preparation for human use, for use as a blood purifier.—Reade Brothers & Co., Ltd., Cleveland Road, Wolverhampton. January 6th, 1926.

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Publisher's Announcements.

The following Books can be obtained from Rea and Inchbould, Merton House, Salisbury Square, London, E.C.4.

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THE CHEMICAL NEWS,
VOL. CXXXII. No. 3433.
MERTON HOUSE, SALISBURY SQUARE,
LONDON, E.C.4.
TELEPHONES :
Administrative : Central 6521.
Printing Works : Hop 2404.

INDEX NUMBER.

containing

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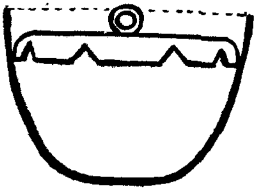
CRUCIBLE METHODS OF ANALYSIS.

By Dr. J. D. Main Smith, B.Sc.

That crucible methods of analysis possess serious disadvantages is well known, and gravimetric methods are, in consequence, avoided wherever possible in favour of volumetric methods. It is commonly, bnt erroneously, asserted that volumetric methods are not only as accurate as gravimetric methods, but result in considerable saving of time and labour. Volumetric methods in general, however, necessitate preliminary standardisations of solutions, often tedious and frequently repeated, and involve bringing substances for analysis into aqeuous solution, preparatory oxidations and reductions, precipitations, decantations, filtrations, washings, re-dissolvings and titrations. These operations are unnecessary in direct gravimetric analyses that can be carried to a conclusion by a single continuous operation in a crucible. Even where the separation of metals must be carried out by " wet " processes, the labour of analysis can frequently be cut short by resorting to crucible methods at a convenient stage of the " wet " operation. Volumetric methods in general involve greater elements of doubt as to analytical reliability, a greater expenditure of time, labour, reagents, and apparatus, and are in the end usually much less accurate than direct crucible methods.

The disadvantages consequent on gravimetric analyses conducted in ordinary crucibles of porcelain, silica, or platinum, result directly from the exterior-fitting lids, and are all simultaneously overcome by the use of an improved form of lid fitting wholly inside the crucible. This lid has the vertical flange serrated round the edge instead of entire, thus allowing free escape to disengaged vapours.



Crucible with Interior-fitting Serrated Lid

(See " Improvements in Analytical Crucibles," J. D. Main Smith, *Journal of the Society of Chemical Industry*, 1925, XLIV., T539.)

In order that the lid may rest stably about a centimetre below the crucible edge, squat-shaped crucibles are used, the tall shape ordinarily favoured for platinum crucibles being disadvantageous. Interior-fitting serrated lids not only completely prevent loses due to spurting and decrepitation, but prevent loss due to " creeping " of heated volatile liquids over the outside of crucibles. Owing to the interior-fitting lid being cooler than the directly-heated

crucible, "creeping" takes place only on to the lid, which, being wholly inside the crucible, thus retains the contents without loss.

Owing to their greater resistance to reagents and their complete freedom from risk of fracture by heating, silica crucibles are far superior, not only in technical but even in economic aspects, to porcelain crucibles for all analytical purposes. The advantages resulting from the use of interior fitting lids are, moreover, much enhanced by the use of silica crucibles. In resistance to the vast majority of analytical reagents and to deterioration by flame-heating, silica is superior even to platinum. Platinum crucibles, for example, are rapidly deteriorated by reducing flames and are attacked in ignitions, fusions, and evaporations by

(a) halogens and substances yielding free halogens;
(b) substances yielding by reduction bismuth, lead, antimony, tin, silver, arsenic, zinc, sulphur, phosphorus, or silicon in the elementary state;
(c) hydroxides and sulphides of and substances yielding hydroxides and sulphides of the alkali and alkaline earth metals, and lead and thallium;
(d) nitrites and nitrates of and substances yielding nitrites and nitrates of the alkali and alkaline earth metals;
(e) cyanides and substances yielding cyanides.

Owing to the ease of alloy formation, moreover, platinum crucibles and lids cannot safely be touched, while red-hot, with metallic tongs. Platinum crucibles find extended use principally because of their lack of fragility and their resistance to acid fluorides.

Silica crucibles, so long as their contents are maintained *continuously* acid or neutral, are completely resistant to all reagents except fluorides. They are attacked only in ignitions, and fusions involving flourides, alkali sulphides, and the oxides, hydroxides, and carbonates of the alkali metals, the more alkaline earth metals, and thallium and lead. They are not appreciably attacked even by the strongly basic oxides, magnesia, lime, lanthana and the other "rare earths," and analyses in the form of these oxides are not impaired in accuracy when performed in silica crucibles.

The crucible, whether of silica or platinum, is placed in a triangle (preferably of silica tubing on nickel or nichrome wire), firmly attached to the ring of a retort-stand or tripod, by bending round the wire ends of the triangle. A retort-stand with a heavy base, a short stout rod, and a ten cm. ring, is much more serviceable than a tripod, as the crucible is more accessible and more easily manipulated. Tripods, moreover, do not admit of altering the height of the crucible above the burner, and are liable to be upset by movements of the hand or burner or by entanglement of the tripod legs with the tubing of the burner or blow-pipe.

The ring and its attached triangle should if possible be reserved solely for analytical use, as a ring or triangle which becomes dirty from other uses is liable to cause deposits on the exterior of crucibles. Care should be taken that in heating crucibles the flame does not "burn back," otherwise deposits of metallic oxides or carbon may occur on the exterior of the crucibles, and platinum crucibles are seriously deteriorated in the reducing flame. Deposits on crucibles, frequently quite invisible to the eye, are one of the common unsuspected causes of high analytical results.

A few drops of the various reagents to be used in the analytical operation should invariably be evaporated to dryness on first bringing a crucible into use, and the crucible ignited to the highest temperature that will be required in the analytical operation. All reagents, both liquid and solid, to be used in crucible analysis should be tested for complete volatility. Three or four grams of the reagent on volatilisation should leave no weighable residue in the crucible. Liquid reagents are most easily added to the crucible by running on to the serrated lid from a small pipette or short drawn-out glass tube with a rubber teat on the wide end. For routine analysis, small stock bottles of tested reagents should be maintained, bottles of liquid reagents being closed with rubber bungs carrying the small teat-ended pipettes.

The crucible, after cleaning and ignition is placed, while hot, in a desiccator to cool. Hot crucibles with interior-fitting lids, are most safely lifted by gripping one side of the upper edge of the crucible with tongs, a light "springy" pair being easiest to manipulate and giving a secure grip, particularly if the jaws are corrugated with a file. Owing to their ready attack by acid vapours, brass or bronze tongs should be avoided in crucible analysis. Nickel tongs are extremely resistant to attack in crucible

analysis, but iron tongs are fairly serviceable if care is exercised in use. Platinum-tipped tongs are unnecessary, except in analysis involving the very highest degree of accuracy.

After cooling to room temperature, the crucible is placed in the balance-case, either on the pan or on a triangle or other support, and weighed after a time. In the case of analyses involving a considerable degree of accuracy, the crucible should remain the same time in the balance-case before each weighing, but, unless a very high degree of accuracy is desired, five to fifteen minutes are ample instead of the hour or more often advocated. Crucibles, however, that will contain a hygroscopic substance *at any weighing* in the analysis, should be weighed on each occasion immediately on removal from the dessicator, and approximately the same time expended in each weighing, so as to obtain an approximate constancy in the effect of atmospheric moisture on the crucible and contents.

Except in the case of analyses involving the highest degree of accuracy, it is an unnecessary refinement and invites accidents to carry desiccators to a balance or to use tongs to carry cool crucibles. So long as the hands are reasonably clean and dry, a crucible may be safely carried between the thumb on the lid-ring and the tip of the middle finger on the bottom. If considered imperative, the crucible, but not the lid, may be gently wiped while held in a piece of silk. For placing on the balance-pan, a crucible with an interior-fitting lid may be lifted between the thumb and middle finger across the diameter of the top edge. The foregoing amounts of handling do not ordinarily affect the crucible weight in the fourth decimal place, and are thus well within the experimental error of the analysis.

The amount of substance to be placed in the crucible for analysis varies with the substance, and with the compound to be finally weighed, but it is usually unnecessary to take more than will yield from one-tenth to three-tenths of a gram of the compound finally weighed. If the amount of the compound finally weighed much exceeds three-tenths of a gram, the analytical operation becomes unnecessarily cumbersome and large crucibles must be used to accommodate the larger amounts of reagents necessary in the analysis, the accuracy of which is lessened rather than increased. In most cases from two-tenths to half a gram of the substance suffices for analysis, but a gram or more may be taken in special cases where a small final weight or only a small difference in weight is to be recorded.

It is often waste of time in crucible analysis to use a weighing bottle as this involves three weighing operations, one for the empty crucible and two for the bottle. By using the crucible instead of a weighing-bottle, only two weighings are necessary. Weights sufficient to give slightly less than the required weight should be placed on the pan, the substance added from a spoon-spatula till the weight is slightly overshot, and the weight then accurately determined. Owing to the risk of damage to the balance by jarring, additions to the crucible on the pan should not be made while the pans are free to swing; the pans should be brought to rest, the addition made, and the pans again set swinging. If other analyses on the same substance are to be performed, the crucible may be used as the weighing bottle for all the weighings, saving at least one weighing or more of bottles. The crucible should first be weighed empty, the total weight of substance added for all the analyses, and successive portions removed for the other analyses with a polished spoon-spatula, finally leaving sufficient for the crucible analysis, the crucible being weighed after each removal of substance. There is no difficulty in removing approximately the required fraction of the total for the separate analyses, and the differences in the crucible weight are almost invariably absolutely identical with the amounts of substance removed, as weighable amounts do not ordinarily adhere to polished metal spatulas. If, however, the substance or the compound to be finally weighed is hygroscopic, the use of the crucible instead of a weighing-bottle, should not be indulged in, as the time expended in each weighing should be approximately the same, and the time would be dangerously long for a hygroscopic substance.

In using crucibles with interior-fitting serrated lids for the ignition of precipitates in wet filter-papers or for the analysis of substances which intumesce on heating or which require to be treated with considerable amounts of reagents in the crucible, a sufficiently large crucible should be used, so that swelling or effervesence of the heated contents does not dislodge the lid. An over-large crucible is no disadvantage,

but an under-sized crucible is usually fatal to the accuracy or success of the analysis. Crucibles from four to five cms. in top diameter are convenient for ordinary analyses, and from five to six cms. in other cases, *e.g.*, the ignition of precipitates in filter-papers.

In inspecting the contents or adding reagents in the course of a crucible analysis, it is unnecessary to remove an interior-fitting serrated lid. The lid easily swivels up by pressing on one side lightly with tongs, thus exposing the contents. Liquids are added simply by pouring on to the lid, the serrations providing ingress, but hot crucibles should be allowed to cool down to near the boiling-pont of the added liquid, so as to avoid dislodging the lid by explosive boiling. It is a very great advantage, though not a necessity, to have the interior-fitting serrated lid made of transparent silica, for use with opaque or transparent silica crucibles or even with platinum crucibles, as the contents can be kept under continuous observation without the necessity for lifting the lid.

If the substance to be analysed is volatile or may yield the metal in the form of a volatile compound, it is necessary before heating to add some liquid fixing-reagent, usually sulphuric or other acid, to retain the metal in a sufficiently less volatile form.

If the substance contains or is present with carbonaceous matter, *e.g.*, filter-paper, this is best destroyed, after any fixing-reagent has been added, by a preliminary heating with the lid on till the excess of fixing-reagent is driven off, the lid then being removed and laid aside upside-down, till later, and the combustion of carbon completed at a red-heat. It is usually obvious to the eye when the combustion of the last trace of carbon has been effected, judged by the cessation of glowing or of travelling sparks on allowing the crucible to cool below red-heat. The lid, if blackened in the preliminary heating, should be held by the lid-ring upside-down by tongs and separately and carefully ignited over the open crucible by means of a small flame so as to avoid loss by draughts, the cleaned lid then being placed rightside-up in the crucible, care being taken that any fragments of residue detached fall into the crucible.

Liquid contents of crucibles with interior-fitting serrated lids can be evaporated to dryness with great rapidity without loss due to spurting, as the serrations allow free escape even to violently disengaged vapours, spurting and spitting merely bombarding the inside of the crucible and lid. No matter how violent the spurting of boiling liquids or pasty masses in the crucible may be, no portion of the non-gaseous contents can be completely lost from the crucible, as the only direction of escape at the serrations is cut off by the vertical wall of the crucible above the level of the lid, ejected portions thus being arrested. Even solids that explode can often be ignited without serious loss, the lid being held down by tongs and a suitable reagent used to wet the substance and the inside of the crucible.

As an interior-fitting lid is not directly heated, and is thus cooler than the crucible contents, the lid should be ignited when necessary by lifting to the crucible edge with tongs, the burner flame being directed slantingly downwards on to the surface of the lid, care being taken that any fragments dislodged in the ignition are not lost, and that rust from the burner does not fall into the crucible. If considered necessary, the lid may be carefully removed and separately ignited upside-down over the flame, losses from draughts or in movements of the lid being avoided.

In cases where substances to be analysed contain only a single metal, it is usually unnecessary to resort to any "wet" process of analysis, the determination of the metal being effected by a single continuous operation in a crucible, with a resultant very great saving of time and labour and an enhancement of the accuracy of the analysis. The same direct process of crucible analysis can be applied to mixtures of two metals, where one of the metals is removable as a volatile compound by the use of suitable volatile reagents in the crucible. Arsenic, antimony, and bismuth, for example, may be readily volatilised as chlorides from mixtnres, by the use of ammonium chloride and concentrated hydrochloric acid. Even in cases where two metals of a mixture are non-volatile in any form, the analysis may often be carried out without the use of "wet" methods of separation by weighing the two metals in two different compounds. Sodium and potassium, for example, may be estimated together by first weighing as chlorides and converting to and weighing as sulphates. Such analyses are greatly facilitated by the use of crucibles with interior-fitting serrated lids. The method, however, is

accurate only if the equivalents of the metals differ considerably.

Gravimetric methods in crucibles with interior-fitting serrated lids have been exhaustively tested for the last five years in these laboratories, and have been applied to the analysis of compounds of almost the whole of the known metals and many of the non-metals, in both organic and inorganic combination. They have been successfully applied, for example, to a large variety of organic and inorganic compounds of metals of periodic group I., lithium, sodium, potassium, rubidium, caesium, copper, silver, and gold; group II., beryllium, magnesium, calcium, strontium, barium, zinc, and cadmium; group III., aluminium, thallium, scandium, lanthanum, and cerium; group IV., tin, lead, zirconium and thorium; group V., bismuth; group VI., chromium, molybdenum, tungsten, and uranium; group VII., manganese; group VIII., iron, cobalt, nickel, rhodium, palladium, and platinum; and to the non-metals, silicon as silica, phosphorus as pyrophosphates, sulphur as barium or lead sulphate, fluorine as calcium fluoride, and chlorine, bromine, and iodine as silver halides.

The alkali-metals (lithium, sodium, potassium, rubidium, and caesium), the alkaline-earth-metals (magnesium, calcium, strontium, and barium), and copper, silver (except when halogens are present), cadmium, thallium, lanthanum, lead, manganese, cobalt, and nickel are very readily and conveniently determined as anhydrous sulphates by the new crucible method described below. All of these metals form anhydrous sulphates which are completely stable just below a visible red-heat, and the method could doubtless be as easily applied to radium. The alkali- and alkaline-earth-metals and silver form sulphates which are stable at a red-heat, but no advantage ensues from ignition to the higher temperature. Copper and magnesium sulphates are hygroscopic, but can nevertheless be easily estimated as sulphates, as the sulphates are obtained in highly crystalline form and no material gain in weight occurs during the time of weighing. The weighing, as also that of the empty crucible, should, however, be performed immediately on removal of the crucible from the desiccator, and approximately the same time expended in each weighing. If halogens are present, silver should be estimated as halide, not as sulphate, as silver halides are convertible to sulphate by sulphuric acid only with great difficulty, and often incompletely.

By the procedure described below in detail, the anhydrous sulphates can be readily obtained in an analytically pure state, every trace of sulphuric acid being removable from the crucible without any decomposition of the metallic sulphate and without any temperature control other than the unaided eye.

Precipitates obtained by "wet" methods may be immediately ignited with their wet filter papers in the new form of crucible and converted to sulphates by sulphuric acid, thus avoiding the drying of precipitates, and the tedious and delicate operation of burning the dried filter-paper in a platinum wire coil. This applies also to the determination of sulphur as barium or lead sulphate, and to the determination of halogen elements as silver halide, sulphuric acid being omitted in the latter determination.

Beryllium, zinc, aluminium, scandium, cerium, tin, zirconium, thorium, bismuth, chromium, molybdenum, tungsten, uranium, and iron, are very readily and conveniently determined as oxides by the new crucible method described below, and the method is also doubtless applicable to gallium, indium, the whole of the "rare earths" except lanthanum, and to germanium, titanium, celtium (hafnium), vanadium, columbium (niobium), and tantalum. As in the case of anhydrous sulphates, precipitates obtained by "wet" methods may be immediately ignited to oxides without preliminary drying and burning-off of filter-papers, but nitric instead of sulphuric acid should if possible be nsed in the ignition.

Gold, rhodium, palladium, and platinum, are very readily and conveniently determined as free metals, obtained simply by ignition of their compounds, in the blast-flame if necessary. The method is doubtless also applicable to iridium, but not to ruthenium and osmium, which form volatile oxides on heating in air. Silver in many of its compounds may also be determined as free metal obtained by simple ignition, but, owing to the necessity for adding fixing reagents such as hydrochloric or sulphuric acid to overcome the volatility, explosibility, or great stability to heat of many silver compounds, silver is best determined as sulphate or as halide if halogens are present, the greater weight

adding perceptibly to the accuracy of analysis.

In crucible analysis generally, precipitates or substances for analysis that contain phosphates or other non-volatile acidic radicals should not be dealt with directly by crucible methods, unless the precipitate or substance has been deliberately obtained pure in this form as in determinations of phosphates, vanadates, molybdates, tungstates, etc. Such pure substances or precipitates must not be treated with any reagent except nitric acid. If hydrochloric acid is used in the crucible, the acid radical may be reduced and volatilised as chloride, and, if sulphuric acid is used, the acid radical may be partially converted into the pyro or meta form together with sulphate of the base, magnesium ammonium phosphate, for example, being converted into a mixture of magnesium pyro- and meta-phosphate and sulphate. The use of nitric acid is essential in ignition of precipitates in filter papers, to re-oxidise any portion of the acidic radical that may have been reduced by carbon in the ignition.

Crucibles with interior-fitting serrated lids of opaque and of transparent silica have been in use in these laboratories for over five years without losing more than a few milligrams in weight or exhibiting obvious signs of wear after performing some hundreds of analyses each. It is certain that every such crucible could have been replaced only by several crucibles with ordinary lids, whether of porcelain, silica, or platinum. The saving in expense of apparatus is obviously considerable, but the gain, consequent on the economy of time, labour, and reagents, on the greater reliability of the analytical methods, the increased accuracy of determination, and on the general facilitation of routine and research work, is incalculable.

Anhydrous Sulphate Method.

The whole of the heating operations should be conducted in a draught-cupboard. Only silica or platinum crucibles should be used, but the use of hydrochloric acid should be avoided in platinum crucibles if there is any danger of the oxidation of the acid to chlorine in the course of the analytical operation, and also in the determination of silver.

The crucible, of squat shape, about 5 cm. in top diameter and having an interior-fitting serrated lid, is cleaned if necessary by brief ignitions with a few drops successively of nitric, hydrochloric, and sulphuric acid, strongly ignited, cooled in a desiccator, and weighed after the usual interval. About 0.4 gr. of the substance to be analysed is accurately weighed into, or the wet precipitate and filter-paper placed in the crucible, and about 2 cc. of strong sulphuric acid added by pouring on to the lid. The crucible with lid in place is heated till the acid is driven off, and ignited at a full red-heat. If carbonaceous matter is present, the lid is removed and laid upside-down until the combustion of carbon is completed in the open crucible. If the lid is blackened in the preliminary ignition, it should be carefully ignited, held upside-down by the ring by the tongs over a small flame until clean. The lid is replaced and the crucible allowed to cool considerably before the addition of about 3 cc. of concentrated nitric and hydrochloric acids, the latter omitted in platinum crucibles and in the determination of silver as sulphate. The contents are then vigorously boiled but not evaporated to dryness. Without cooling, about 3 cc. of strong sulphuric acid are added and the boiling continued. The anhydrous sulphate separates in crystalline form as the liquid is quickly evaporated nearly to dryness. The crucible is from henceforward heated only by a flame having the air-supply cut off till a large wavy flame is obtained which is *just not luminous*. The crucible should be enveloped in this large comparatively cool mantle of flame, and should not be allowed to become visibly red-hot in any part, this being effected by keeping the flame moving. The lid is occasionally lifted when the residue is dry, and the heating continued until no trace of white vapour comes from the crucible on removing the flame and immediately lifting the lid about an inch above the edge of the crucible. The least trace of acid in the crucible yields a slight white vapour of sulphur trioxide, easily perceptible to the eye. After heating for a few moments longer, the crucible is placed in a desiccator to cool, then removed to the balance-case and weighed after the usual interval. The crucible should be re-ignited with a few drops of strong sulphuric acid, but usually there is no difference in weight. For determinations in which an accuracy of about 0.5% is sufficient, a discrepancy in the fourth decimal place on re-weighing can be disregarded, as either weight is within the desired limit of accuracy.

To ensure that the analysis has been propertly performed, 5 cc. of water should be added to the crucible and the sulphate, if soluble, brought into solution by warming, whereupon a clear solution should be obtained. If the sulphate is insoluble in water, its purity can usually be judged, before and after adding water, from its colour and the absence of black specks. The analyst should become acquainted beforehand with the colour of the ignited anhydrous sulphate by a preliminary ignition of the pure nitrate or chloride of the metal with strong sulphuric acid, and, with very little experience, can decide in how far the true colour of the pure sulphate may be departed from without endangering the accuracy of the analysis. If the final ignition is just below a visible red-heat, there is usually no difference in colour between the sulphate obtained and that of an ignited pure specimen.

A determination of a metal as anhydrous sulphate, in a silica or platinum crucible with an interior-fitting serrated lid, can usually be completed from initial to final weighing in less than an hour, and, in the case of inorganic substances, in about half an hour, whereas two to three hours or more are required with ordinary crucibles and three hours to a day or more by "wet" methods.

With no great care in analysis, the accuracy of the analysis is within 0.1%, and, with due precautions and refinement, the method is capable of giving results of the very highest degree of analytical accuracy.

In all determinations of metals as anhydrous sulphates, the preliminary ignition with sulphuric acid should be followed by boiling with nitric and hydrochloric acids, with the exceptions above noted, so that any redneed metal is dissolved prior to the final ignition witb sulphnric acid, in which some metals are soluble only wth difficulty, and also so that the anhydrous sulphates are obtained in a crystalline condition by precipitation from a hot acid solution.

Oxide Method.

The procedure is similar to the foregoing except that, if the substance contains no halogen, it may usually be ignited directly to oxide without the addition of acids, or after the addition of nitric acid alone. However obtained, the oxide should be ignited to a full red-heat before weighing. If a halogen is present or the metal is in a volatile form or may form a volatile compound on heating, the procedure is the same throughout as for anhydrous sulphates, but the sulphate is finally converted into oxide by ignition at a full red-heat. In many cases, even when a halogen is present, ignition with nitric acid suffices to obtain the pure oxide without the use of sulphuric acid. The use of sulphuric acid should be avoided wherever possible in the analysis, particularly of compounds of bismuth, scandium, zirconium, and thorium, and also doubtless in the case of compounds of yttrium and the "rare earth" metals in general, owing to the difficulty of decomposing the last trace of sulphate. If sulphuric acid must be used, the final adition of ammonia or ammonium carbonate facilitates the formation of the pure oxide without the prolonged blast-ignition usually necessary.

The oxides of molybdenum and tungsten, and doubtless also those of vanadium, columbium, and tantalum, should invariably he ignited finally with a few drops of nitric acid to ensure that the metals are in the highest condition of oxidation before weighing. Uranium, though weighed not as uranic anhydride, UO_3, but as uranous uranate, $U(UO_4)_2$ or U_3O_8, should also be ignited with nitric acid to form uranic anhydride prior to the final ignition to the lower oxide.

The determination of metals as oxides in crucibles with interior-fitting serrated lids can usually be effected in from one-half to one hour, whereas with ordinary crucibles, two to four hours or more, and three hours to a day or more by "wet" methods, are required. The accuracy of analysis is almost identical with that hy the anhydrous sulphate method.

Free Metal Method.

The procedure is the same as for oxides, except that the substance can usually be reduced to metal by simple ignition, preferably by blast-heating, without the addition of any acid, the entire determination often occupying about half an hour. Some "noble" metal compounds are, however, reduced to metal only at a temperature approaching a white-heat, and prolonged blast-heating must be resorted to, with consequent greater expenditure of time in analysis. Palladium compounds are occasionally volatile and sulphuric acid must be added; on ignition palladous sulphate is converted chiefly to oxide, but the free

metal is readily obtained at a full red-heat in the blast-flame, and the metal thus obtained is not perceptibly re-oxidised during cooling in a desiccator.

The accuracy of analysis in crucibles with interior-fitting serrated lids is in all cases comparable with that by the anhydrous sulphate method, owing to the high atomic weights of the "noble" metals. The time occupied by an analysis, *where acids have to be added, is similar to* that by the oxide method and invariably much less than that involved by the use of ordinary crucibles or by "wet" methods.

If "noble" and "base" metals are to be determined together, the "base" metal may be weighed as sulphate, oxide, or other compound stable at the temperature at which the "noble" metal compound is reduced to metal. The crucible is then washed out with water or a suitable acid and the "base" metal brought into solution, the "noble" metal being filtered off, washed, re-ignited with the wet filter-paper, and again weighed, the difference between the weighings being the weight of the "base" metal compound. Such direct simultaneous analyses, though infrequently available, can usually be completed in less than an hour and a half, and *are thus very valuable both for their* rapidity and accuracy. Rhodium, however, cannot be determined if the "base" metal compound is the sulphate of one of the more alkaline bases, owing to the partial formation of double-sulphates on oxidation of the rhodium by the first-formed alkali-metal acid sulphate. If alkali-metals are present, the use of nitric acid in the crucible may lead to the formation of alkali-metal nitrates or nitrites, with resultant oxidation of the "noble" metals, the oxides of which are often difficultly decomposable in the presence of such alkali salts. Palladium, and platinum, for example, and probably also iridium, are difficult to determine accurately by direct *crucible methods unless alkali nitrates and* nitrites are destroyed.

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FELDSPAR.

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The feldspar industry in 1924 was exceedingly prosperous on the whole, and made notable progress in output and in the better preparation of material for the market. The quantity and value of crude spar were by far the largest ever recorded. The quantity was 41 per cent. greater than that of 1923 and 69 per cent. greater than that of 1914. The value was 43 per cent. higher than that of 1923 and 140 per cent. higher than that of 1914. The greatly increased production of crude feldspar, especially in North Carolina, is explained *by the fact that some grinders of feldspar* found themselves late in 1923 with low stocks of crude spar which they were un*able to replace during the winter.* The desire to avoid similar conditions in 1924-25 led to increased production in 1924, hence the mills had large stocks on hand at the close of the year.

Imports of feldspar increased in even greater proportion than did production, but as they constituted less than one-sixth of the total supply in 1924 the domestic industry does not seem to be menaced.

Notwithstanding the large increase in production and imports, the sales of ground feldspar increased by little, probably because the pottery industry was not so *active in 1924* as in previous years. The sales might have been even smaller but for the glass industry, as manufacturers of bottles and preserving jars are now large users of feldspar.

Production.

Statistics of production of feldspar are presented separately in tabular form as crude feldspar for mine and quarry output, and as ground feldspar for mill output. The crude feldspar is reported in tons of 2,240 pounds, and the ground feldspar in tons of 2,000 pounds, according to the common practice in the industry. The average value of crude feldspar in 1924 at the mine or shipping point nearest thereto was $7.37 a long ton—8 cents higher than that of 1923. The average value of domestic ground feldspar was 46 cents a short ton higher than in 1923, and that of Canadian spar ground in the United States was $1.04 a ton higher. The average values of crude spar as reported by individual producers

ranged from $2 to $16.74 a long ton. For New England the range was from $8.73 to $16.74; for Maryland, New York, Pennsylvania, and Virginia, from $3 to $8.93; for North Carolina, from $2 to $8.86; and for Arizona, California, and Colorado, from $5.60 to $10.08.

FOREIGN PRODUCTION.

A considerable part of the supply of feldspar annually available for the ceramic and other feldspar-consuming industries in the United States is mined in Canada. According to reports of the Dominion Bureau of Statistics the Canadian shipments—all from Ontario and Quebec—amounted in 1924 to 38,411 short tons, valued at $299,174, or or $7.79 a ton, an increase of 31 per cent. in quantity and 26 per cent. in value compared with 1923. Of the total quantity 37,869 tons (99 per cent.) was exported, most of it to the United States. The sales of Canadian spar ground in the United States in 1924 constituted 14 per cent. of all ground spar sold in this country in that year, which was the same percentage as in 1923.

UNITED STATES BUREAU OF STANDARDS.—ANNUAL REPORT.

(Continued from Page 58, January 22 issue.)

Fire Tests of Walls Under Load.—Equipment was completed for conducting fire tests of wallls under loads equivalent to those they are designed to carry in buildings. In a series of fire tests of brick walls their ability to sustain such loads up to or beyond the point at which the temperature on the unexposed side would cause ignition of combustible materials was definitely determined.

Specific Heat of Oils.—Measurements of the specific heats of a large number of oils specific heat of an oil can be inferred to an have led to the generalisation that the accuracy of a few per cent. from a knowledge of its origin and its density, at least for the temperature range up to 100° C., and possibly for much higher temperatures. The results are being prepared for publication.

Performance of Automobile Brakes.—In connection with the formulation of a Safety Code for Automobile Brakes and Brake Testing, the stopping ability of about 500 cars, including trucks and buses, has been measured.

Another factor closely related to highway safety is the reaction time of the driver. Measurements were made of the reaction times of more than 50 drivers over wide range of conditions, and values of from 0.3 second to more than 1.0 second were obtained, the average being slightly over 0.5 second.

CHEMISTRY.

(P. H. Walker, Acting Chief.)

General Chemical Testing.—A great part of the energy of the chemistry division has been expended in the testing of materials for the Government service.

Preparation of Specifications.—A large number of specifications covering soaps, inks, paint materials, roofing materials, etc., were prepared for the Federal Specifications Board and have been adopted as United States Government Standards. Others are in preparation, and several special specifications, including a number for chemical reagents, have been prepared for various branches of the service or in co-operation with technical and scientific societies.

Standard Samples.—Renewals of 5 exhausted standard samples were prepared. Five new standard samples were added to the list during the year, making the total number now available 63, and 4 more are in process of preparation. The constant demand for the Bureau of Standards standard samples by chemists from all parts of the world clearly shows the great value of this service.

Study of Methods of Analysis and Test.—A number of new and improved methods of chemical analysis were developed during the year, and several new methods of physical testing were devised. These included phosphate rock analysis, simplification of use of Jones reductor, aluminium in non-ferrous alloys, alkali in silicates, separation of manganese, dental gold alloy analysis, gas analysis by fractional distillation, fading of dyed fabrics, hardness of varnish, and hiding power of paint.

Safety of Gas Appliances.—Important progress has been made in the study of the utilisation of gas. Methods have been developed for determining with reasonable rapidity the margin of safety of gas appliances from three hazards—flash back, the blowing out of flames, and incomplete combustion. The work was done as part of a co-operative programme for the improvement of gas appliances entered into

with the American Gas Association, and the methods developed are expected to find immediate application in reducing the hazard from the use of gas.

Efficiency of Different Fuel Gases.—A careful review of all available information regarding the relative efficiency of different fuel gases in use has shown that for all ordinary uses of gas the purchaser is equally well served by the same amount of heat from gases of different heating values and is really concerned only in getting the most potential heat possible for a dollar.

Chromium Plating.—During the past several years there has been a great interest in chromium plating, and several commercial research laboratories have studied the problem. Thus far, however, there have been very few commercial applications.

Protective Value of Nickel Plating on Iron and Steels.—The results of an extensive study of this subject show that, in general, nickel plating does not protect iron and steel against corrosion for long periods, because nickel deposits are invariably porous. It is not possible by any known methods to eliminate entirely this porosity, but it can be greatly reduced by increasing the thickness of the nickel. Where protection against corrosion is an important consideration, the nickel plating should be at least 0.001 inch thick.

Nickel Plating on Zinc and Zinc-Base Die Castings.—The results of this study showed that by the addition of relatively large amounts of sodium or magnesium sulphate to the customary nickel-plating solutions, very satisfactory deposits can be made on zinc and die castings. Such solutions have very good conductivity and throwing power and are therefore also very useful for barrel plating of small brass or steel articles.

Purification of Platinum.—Experiments were made to determine whether it is possible to remove collectively the impurities which occur in various forms of platinum, thereby greatly curtailing the time and expense involved in the preparation of pure platinum. In the case of ordinary platiuum scrap, from which gold, ruthenium, and osmium were absent, a precipitation of the impurities by sodium hypobromite, followed by one precipitation of ammonium chloroplatinate, yielded metal which was probably better than 99.99 per cent. pure. Adaptation of this proceedure to other forms of impure platinum is in progress. This method is essentially a development of various alkaline precipitations which are reported in the literature which fail to meet the conditions for successful use.

Aluminium Paint.—It has been shown that when a proper vehicle is used, polished aluminium powder mixed on the job gives a good paint for protecting iron and steel. Boiled linseed oil or raw linseed oil and drier are durable vehicles and would be suitable if only horizontal surfaces were to be painted, but such paints are liable to run and streak on vertical surfaces. It is therefore better to use a vehicle of heat-bodied linseed oil or long oil water-resisting varnish; about 2 pounds of polished aluminium powder to 1 gallon of such vehicle makes an excellent paint.

Trade and General Notes.

MEDICINE AND THE LAW.

Cancer in Tar-Workers.

A recent inquest in Manchester indicated once more the danger of cancer where workmen are employed in contact with tarry substances. The deceased man had worked for twenty-four years at the Bradford Road gas-works of the Manchester Corporation. According to the evidenee reported in the *Manchester Evening Chronicle*, he developed a growth on the knee in 1918, underwent operation at Manchester Royal Infirmary, and resumed work at the end of that year. Another growth formed in 1923, and after a second operation he again took up his work, but finally gave it up at the end of 1924. The Coroner, Mr. C. W. W. Surridge, said there was no doubt that death was occasioned by the cancerous growth due to the nature of his work, and a verdict to that effect was returned. The manager of the gas-works, who stated that this was the first case of the kind to come to his notice, though a second case has since been reported, was questioned by the coroner as to the possible use of protective clothing. He replied that there had been a difficulty in finding suitable clothing, and that rubber had not been found satisfactory. Dr. W. Faith, who also gave evidence, advised that workmen thus employed should be periodically examined in order that early operation might be performed where a growth was discovered. The coroner recommended that some such system of examination should be adopted.

It will be recalled that in November, 1919, a Special Order of the Home Office, made under Section 73 of the Factory and Workshop Act, applied that section (notification of disease) to epitheliomatous ulceration due to tar, pitch, bitumen, mineral oil, or paraffin, or any compound or residue of these substances, occurring a factory or workshop, Regulations enjoining the use of protective clothing, gloves, etc., in trades specially classed as dangerout have not infrequently been made under Section 79 of the Act. In particular, the Chemical Works Regulations of 1922 contain provisions of this noture, but they are expressly excluded from application to the "manufacture and necessary purification of coal, gas, water gas and producer gas for lighting, heating and power purposes." Pending fresh legislation the special need appears to be, as the coroner observed, that workers should voluntarily submit themselves for examination at the first suspicion of any trouble. It should not be impossible to bring to the knowledge of all workmen concerned the protection which early treatment provides and the danger of delay. —*The Lancet.*

A NEST OF EGGS 10,000,000 YEARS OLD.

Returning recently from his fourth Asiatic expedition, Roy Chapman Andrews, noted naturalist and explorer from the American Museum of Natnral History, New York City, brought with him 40 dinosaur eggs believed to be 10,000,000 years old. Included in the remarkable collection is a nest containing a dozen of the prehistoric eggs. These recent discoveries have added new weight to the theory advanced by some scientists that Central Asia was the first home of reptiles and mammals.—*Popular Science Monthly.*

A STRANGE "FACTORY."

In London you can get a bargain in germs. A quarter of a dollar will buy millions, and you can have your choice of more than 2,000 kinds.

There has been a great demand for germs lately from laboratories and hospitals, and workers in the Lister Institute are kept busy feeding, raising, and bottling them to ship to the far corners of the earth.

Many of the germs are cranky boarders, and the *chef* has to make special dishes for them. A favourite food is beef tea, but others will touch only dishes in which eggs are used. Topers in the assembly demand alcohol in their foods.

Some of the germs demand a lot of coddling. The "flu" germ, for instance, has to be kept at a certain even temperature in an incubator night and day, lest it catch cold and die.—*Popular Science Monthly.*

THE KING AS PATRON.

The King has consented to be patron of the next annual general meeting of the Society of Chemical Industry, to be held in London in July. The third Messel Memorial Lecture will be delivered by Lord Balfour at the opening meeting at the Mansion House, over which the Lord Mayor is to preside.

THE TRADE OF THE POTTER.

The potter's trade goes back to prehistoric times, like the rest. The materials which he uses are found in the earth: some of them very commonly, some in a few places only. His skill in using them is the result of ages of trial and error. It is perhaps more difficult than in any of the other constructive trades to get to an understanding of all the processes that are involved. The natural materials which he uses are very complicated in structure, and their association in the heat of the furnace presents many problems not yet solved. The atoms of oxygen, silicon and aluminium, are the most numerous of those of which the world is made: their combinations are among the most intricate.—*Sir William Bragg, F.R.S.*

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read on Thursday, January 21, 1926, at 4.30 p.m.—

Structure of a Quartz. By R. E. GIBBS. Communicated by Sir William Bragg, F.R.S.

Investigations on quartz have shown that symmetry and X-ray data enable only partial definition of structure. Complete determinations involve more parameters

than can be evaluated by this means. For solution of the remaining four unknown variables intensity measurements and general physical properties of the material must be studied.

Observations of intensities of reflection from a number of planes were made by oscillation, rotation, Laue photographs, and ionisation spectrometer. It was proved that the O atoms do not lie either in same basal planes as the Si, or halfway between, but rather occupy positions $c/9$ above and below.

The variation in the values of the physical properties is in favour of only a small structural change accompanying the transition from β to α quartz, but still the tetrahedral character of the former structure must be lost. The structure proposed assumes the crystal to be non-molecular and the oxygen to occupy basal planes as noted above. Evidence is advanced for a movement of the silicon atoms of about 0.3 A.U. from their β-positions, and intensities were calculated for various values of the remaining two parameters.

The Structure of Thin Films, Part VII. Critical Evaporation Phenomena at Low Pressures. By N. K. Adam and G. Jessop. Communicated by Sir William Hardy, F.R.S.

By means of a new apparatus, measurements of the surface pressure of monomolecular films have been made at room temperature, down to 0.01 dyne per cm.

At areas greater than about 5,000 sq. A.U. per molecule, the pressures exerted by films of insoluble fatty substances tend to a value within 25 per cent. of that given by the equation Fa = RT, R having the same value as in a perfect gas. The experimental difficulties of measurement at these areas are so great that it is probable that the divergences from the theoretical values are within experimental error.

Between 100 and 5,000 sq. A.U. the pressure-area isothermals closely resemble those for liquid and vapour in three dimensions. With longer chains in the molecules there is a horizontal "vapour pressure" region, ending, on the one hand, in an imperfect gaseous film, on the other, in either the condensed or the expanded type of film. When the chains are shorter, a condition which corresponds to a higher temperature, the "vapour pressure" region, disappears, and the films are above their "critical point."

Expanded films are analogous to liquids, not vapours, and there is considerable cohesion between the molecules in them. The heats of two-dimensional evaporation from expanded to gaseous films are of the same order of magnitude as the heats of spreading, from bulk to a condensed film, on a water surface.

The Behaviour of Single Crystals of Aluminium under Static and Repeated Stresses. By H. J. Gough, D. Hanson, and S. J. Wright. Communicated by Dr. T. E. Stanton. F.R.S.

The Determination of the Vapour Tensions of Mercury, Cadmium and Zinc by a Modified Manometric Method. By C. H. M. Jenkins. Communicated by Dr. W. Rosenhain, F.R.S.

In this investigation a new method has been developed which is capable of operating over wide ranges of temperature and pressure, and suitable also for most liquids. The apparatus consists of a specially designed manometer, using the material under determination as the observed liquid in this gauge. The size of the apparatus is such that it can be inserted in a 3-inch diameter electric tube furnace for heating the substance to the necessary temperature. The pressure on the apparatus is regulated by means of nitrogen, whose pressure is measured on an independent barometer.

The vapour pressure of the liquid is measured over a free surface in the closed end of the manometer, by alterations in the pressure of the nitrogen to bring both liquid surfaces in the guage level. The nitrogen pressure is then read on the barometer.

The apparatus is similar to the letter V in shape. One extremity is closed; the other opens into a long straight column bent at right angles to it. Into this column specially shaped pieces are inserted, transforming this portion of the tube into a reflux condenser, which counteracts the diffusion of the nitrogen into the vapour. A glass apparatus was used for the mercury determination, and a transparent silica one for cadmium and zinc.

Foreign gases can be removed from the closed end of the manometer by tilting the apparatus, thus causing the closed end to be flooded. The liquid can also be boiled vigorously to remove any entangled bubbles of foreign gases. No great difficulty was experienced by the formation of bubbles in the liquid.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Notes on the Testing of Static Transformers, by J. Lindley Thompson, M.Sc., Member, and H. Walmsley.

The paper describes the usual methods adopted in the commercial testing of static transformers. Emphasis is laid on the need for accuracy, and methods are suggested whereby it can be obtained.

The drying-out of transformers, the determination of dryness, and the measurement of insulation resistance are discussed. The measurement of the iron loss and the load loss is described, together with methods for obtaining greater accuracy.

The measurement of form factor and its effect on the loss measurements are dealt with; and methods for determining the ohmic resistance, also corrections for the same, are detailed.

The loading of transformers for a full-load test, and the temperature-rise readings obtained on this test, are discussed. Over-potential and pressure testings are described and the methods of measuring high voltages are detailed.

In this paper the authors describe how transformers can be efficiently tested, and also some of the methods employed for determining and correcting any measurements taken.

Accurate results are essential in all the various tests. This tends to create confidence in the mind of the customer, and also gives the designer and manufacturer confidence in their product.

Testing serves as a check on workmanship, materials, design, and drafting, and should function as the most critical inspection of the product.

Apart from the visual inspection and the testing of mechanical attachments, the following general tests are required on all transformers, in order to ensure their satisfactory design and manufacture :—

(1) Ratio.
(2) Polarity.
(3) Iron loss and magnetising current.
(4) Copper or load loss, and impedance
(5) Resistance, cold and hot.
(6) Full load temperature run.
(7) Over-potential tests.
(8) Pressure tests.

Accurate Testing.

To ensure accurate testing there are a few simple precautions that should always be taken.

It is essential first of all to study the requirements of the transformers under test as regards the instruments most suitable, in order to prevent overloading or subjecting them to a higher pressure than that for which they are designed. This precaution may seem obvious, but unless carried out, it may easily involve the destruction of, or damage to, valuable instruments.

The method of carrying out the test should be studied so that the most accurate one may be employed. The means employed also require thought, so that the best and most favourable condition may be selected. A little thought in this direction may often save the overloading of a generator or auxiliary transformer, and so tends to lengthen the life of the test plant. Where a considerable amount of auxiliary apparatus and plant is required to carry out a particular test, it is wise to draw up a clear, full diagram of connections and also to set out the sequence of the operations to be performed, together with a table of all load currents, voltages, frequencies, oil flow, and water quantities, etc., that will be required. To ensure accurate testing, it is essential that all instruments should be well cared for, checked, and calibrated at regular intervals.

Preliminary tests should be carried out on all transformers during the process of manufacture, in order to ensure a satisfactory product and prevent, as far as possible, time and labour being spent on a defective unit. These tests being repeated in the final stage, the authors do not intend here to describe them.

Drying-Out and Insulation Resistance.

Before final tests are carried out on a transformer, it is essential that it be in a safe condition for those tests. This condition is that it be thoroughly dry and free from moisture. The drying-out of transformers is in reality a test of insulation resistance. By this is meant not the actual insulation-resistance value obtained from any megger reading, but the insulation characteristic with time and constant temperature.

There are many well- known ways of drying out transformers, the most satisfactory being those carried out by the circulation of dry, heated air and by the vacuum process.

Drying-out by the circulation of dry heated air should be confined, from the point of view both of efficient drying and of the necessary time taken to ensure dry-

ness, to transformers wound for voltages not higher than 11,000. This method is carried out in an enclosed heat-insulated chamber fitted with a steam pipe or heating element under the floor. Air inlets are provided underneath the heating elements, and outlets provided in the roof ,thus ensuring free circulation of air.

The temperature necessary in a drying-out chamber of this description is about 80° C., and the time required varies with the size and construction of the unit, *i.e.*, it depends on the quantity of insulation embodied therein. The length of time can be gauged from the dielectric characteristic, as shown by the curve of megger readings taken during the process. It is not essential to take the characteristic of the insulation for all transformers dried out by this method, though, if possible, it is advisable, for if we determine the necessary time and allow a safety margin, similar units may be assumed to take the same time.

It is necessary, however, to " megger " each transformer finally before withdrawing it from the drying-out chamber, *i.e.*, at its maximum temperature, in order to ensure it being in a safe condition for the tests it has to withstand. In the case of transformers, and especially high-voltage transformers which have a high electrostatic capacity and so require an appreciable charging current, in order to ensnre that a reading as reliable as possible is obtained the megger voltage should be applied for at least 60 seconds.

A high-voltage megger is essential, *i.e.*, one wound for 1,000 or 2,000 volts. As a guide to megger readings, when a transformer is dry the following empirical formula, in which f is the frequency, will be useful :—

$$\text{Megohms at approx. } 75^\circ = \frac{\text{Kilovolts} \times 20}{\sqrt{\dfrac{(\text{kilovolt-amperes})}{f}}}$$

When the transformer is immersed in oil, its megger reading for the same degree of dryness will be much lower than when in air. This is due to the fact that when immersed in oil the resistance is the resultant of an infinite number of high-resistance paths in parallel, whereas when dry the resistance is confined to the insulation in contact with the windings and the core or earth. A new transformer that has never been dried may show a megger reading of " infinity " when cold, but when heated, the moisture that has been absorbed, and may be localised, is dissipated throughout the windings and insulation, thns the insulation resistance will fall to the region of zero. With the continued application of heat the dissipated moisture becomes liberated and the megger reading will gradually rise to a safe or infinite value. In general a transformer may be said to be dry if the insulation resistance is at a high or infinite value when the transformer is heated up to a temperature of 80°-85° C. For transformers for higher service voltages than 11,000, the vacuum process of drying is recommended as being the surest and quickest way of obtaining the desired result. This method is really an extension of the method already described, the drying-out being accelerated by the application of a vacuum in order that the moisture may be more rapidly vaporised and liberated.

VAPOUR PRESSURE AND HEAT OF DILUTION OF AQUEOUS SOLUTIONS.

By Edgar Philip Perman, D.Sc., and Trevor Lovett, M.Sc.

(A paper read before the Faraday Society, Monday, January 10, 1926.)

Previous work on this subject was carried out by Perman and Price, by an air-bubbling method. Their results were criticised by Porter and Wood and shown to be not very accurate. Fresh determinations have been made therefore by the statical method described by Perman and Saunders. This method has been shown to be capable of great accuracy, and is more reliable than the air-bubbling method. With the exception of one or two slight improvements, the method was identical with that used by Perman and Saunders. It was found that in boiling off air from the solutions " bumping " could be prevented by placing in the solution a small cone of platinum foil. This made the boiling quite regular and easy. The platinum lost its power after a time, but could be renewed by heating to redness. The measurements were made at five temperatures, 40°, 50°, 60°, 70°, and 80°, (approximately), and over a wide range of concentrations. The concentrations is expressed in three ways: (*a*) Ratio of the number of molecules of urea to the number of molecules of water,

$\frac{n}{N}$; (*b*) number of grams of urea in 100 grams of solution; (*c*) number of grams of urea in 100 c.c. of solution.

SUMMARY.

(1) An original method is described by which the heat of solution of concentrated solutions can be measured.

(2) From the results obtained it is possible to obtain the heat of dilution as defined by Kirchhoff's Equation, the total heat of dilution between any two concentrations, and the relation between the heat of dilution and the concentration.

(3) The heats of dilution calculated from the vapour pressures are compared with those directly observed, and a fair agreement in order, and agreement in sign is shown.

(4) A new method of determining solubilities is suggested.

University College,
Cardiff.

GEOLOGICAL SOCIETY OF LONDON.

Dr. J. B. Evans, F.R.S., presided over the meeting held on January 6. The following communication was read :—

...*Fossil Plants from the Nubian Sandstone of Eastern Darfur.* By WILFRED NORMAN EDWARDS, B.A., F.G.S.

The plant-remains described in this paper were found in 1924 by Mr. G. V. Colchester, Assistant Geologist to the Sudan Government, at Jebel Dirra, 75 kilometres east of El Fasher in Darfur. They occur in highly silicified quartzitic sandstone, belonging to the Nubian Sandstone, and are the first fossile to be found in that formation in Darfur. The species identified, which probably grew in dune conditions, are *Weichselia reticulata* (Stokes & Webb), *Frenelopsis hoheneggeri* (Ettingshausen), *Dadoxylon ægyptiacum* Unger, and indeterminable fern-fragments. They afford strong evidence for assigning the beds in which they occur to the Lower Cretaceous, or possibly to the base of the Upper Cretaceous.

DISCUSSION.

The President said that it was remarkable that the same species, *Weichselia reticulata*, should occur in places so far apart as Peru and Darfur. He was aware that some species of recent plants were common to the Old and the New Worlds, but was not aware that this was the case with any desert plants. The wide distribution of this Cretaceous desert species lent some support to Wegener's contention that South America was once in close proximity to Africa.

Prof. J. W. Gregory wrote that, presumably, the age assigned to the Nubian Sandstone was based on the *Weichselia* and the *Frenelopsis*, as the typical locality of *Dadyoxylon ægyptiacum* is the Lower Oligocene fossil-forest near Cairo, and it was their found with *Nicolia ægyptiaca* Unger, which had been recorded by the Author from the Upper Eocene in Somaliland. Prof. A. C. Seward refers to *D. ægypticum* as Tertiary, so that apparently neither the *Dadoxylon* nor the *Nicolia* are of any particular value in indicating age. The Lower or Middle Cretaceous age assigned to the Nubian Sandstone is fully consistent with the Somaliland evidence.

Mr. W. Campbell Smith said that Admiral Hubert Lynes had collected specimens of these sandstones in the neighbourhood of Um Kedada (Darfur) in 1920, and in 1921 he had proved their extension in a north-easterly direction to Jebel Meidob, but at no locality had he succeeded in obtaining fossils. Mr. Colchester was to be congratulated on having obtained these fossils. His discovery of them and their identification by the Author were of the first importance.

The Author, in reply, suggested that the wide distribution of *Weichselia reticulata* might be connected with its strand habitat. In reply to Prof. Gregory, he pointed out that the type of coniferous wood known as *Dadoxylon ægyptiacum* was found in Cretaceous as well as in Tertiary rocks, and that ,like most anatomical form-species of fossil wood, it was of uncertain value as an indicator of geological age.

MINERALOGICAL SOCIETY.

The following papers were read at the meeting held on January 19, 1926, Prof. W. W. Watts, M.A., F.R.S., President, in the chair.

Some Mineralogical Transormations in Crystalline Schists. By DR. C. E. TILLEY.

Attention is devoted to the pelite isochemical rock series with special reference to the mode of origin of the index minerals biotite, almandine, staurolite, etc., in crystalline schists. A fuller recognition of

the element of progression in metamorphism brings inevitably in its train this genetic problem, hitherto greatly neglected. Mineral and rock analyses are graphically represented in triangular plots. Examination shows that the mechanism of the mineralogical transformations is something much more complex than is explained away by the customary simple equations. Further insight into the prevailing reactions depends very largely on a closer chemical investigation of these common metamorphic minerals occurring in the ground mass of the crystalline schists.

Primary Gold and Silver in the Dartmoor Granite. By DR. A. BRAMMALL.

Occurrences of minute flakes of native gold in the normal grey biotite-granite were described and specimens were exhibited. The occurrences were shown to be independent of quartz-veins, tourmaline veins, and zones affected by pneumatolysis, and flakes occur as inclusions in felspar and quartz. A suite of assays of apparently barren tor- and quarry-granites, graphic granite, pegmatites, and vein pyrites, shows that both gold and silver are widely distributed throughout the granite, the values ranging from 1·10 grains of gold and 1·161 grains of silver to the ton. Both metals are undoubtedly primary.

On the Chemical Classification of the Mica Group. II. The Mica Basis. By A. F. HALLIMOND.

In continuation of previous work on muscovite, the analyses of biotite and phlogopite are re-calculated in molecular proportions, SiO_2 being made equal to 600. The ratio of potash is approximately constant, as in the acid micas. Values for the R_2O_3 and RO groups are plotted in a diagram which makes it possible to compare any new analysis with existing data. On this diagram biotite and phlogopite form a continuous series, covering a very well-defined area and separated from muscovite by a wide interval. The representation of alumina in the form of basic groups, AlO etc., leads to the classification of the micas in a range of increasing acidity from muscovite to phlogopite. This arrangement corresponds generally with the gradation in acidity of the rocks from which the respective micas were derived. The micas can be represented either by hexasilicic or trisilicic formulæ.

The Construction and Use of an X-ray Goniometer. Crystal Structure of Glyoxaline Compounds. By G. GREENWOOD.

A new form of X-ray spectrometer has been constructed. It embodies the principles of the optical goniometer. The crystal is mounted on a goniometer head rotating about an upper scale, and the adjustments are made optically by means of a telescope and collimator. In using the apparatus, a source of X-rays is used, instead of a source of light and an ionisation chamber instead of a telescope. The ionisation chamber rotates round a second scale, concentric with the upper crystal scale. Small and transparent crystals are usually used, and it is then possible to measure the crystallographic angles, *i.e.*, angles between crystal faces or lattice planes of the structure, and in this way to make the ordinary angle measurements even when the faces are not actually present. It is also possible to measure glancing angles and spacings, and thus to make determinations of the space-group to which the crystalline structure belongs. Two substances were investigated (*a*) glyoxaline-4-sulphonic acid. The space group was determined and the crystal class —previously determined from the alternating presence of minute faces—was confirmed. (*b*) Glyoxime. This substance does not form complete crystals. It was possible to measure crystal angles, and deduce the axial ratios, etc. The symmetry is monoclinic.

FARADAY MEDAL AWARD.

The Council of the Institution of Electrical Engineers have made the fifth award of the Faraday Medal to Colonel R. E. B. Crompton, C.B., honorary member of the Institution.

Colonel Crompton, who has twice been president of the institution, is one of the pioneers of electrical engineering, and has played an outstanding part in the development of electricity supply in this country.

NOTICES OF BOOKS.

Structure des Molécules par V. HENRI. Pp. 122. Paris: Librairie J. Hermann. 1925. Price 20 francs.

Prof. Henri has published in book form the subject matter of a series of five lectures given at the Collége de France and before the Société de Chimie physique.

The first deals with the polarity of molecules and is introduced by an account of the views of Langevin, Debye and Born.

The structure of molecules is then considered from the results of X-ray and absorption spectra examination. In the last section the author discusses the structure of benzene and its derivatives in the light of modern physical knowledge.

The work is written in an easy style, and the argument may generally be followed without much difficulty.

Úvod do Chemie Radioaktivních Látek. By Dr. A. S. Russell, Translated into Czech by Dr. A. Simek (Professor of Physical Chemistry at the Masaryk University, Brno). Pp. X + 116. Brno: Nakladatel A Pisa. 1925. Price 20 Czech crowns.

It is some time since we reviewed Dr. Peklo's *Principles of the Physiology of Plant Nutrition*, published in Pisa's series of scientific monographs (see *Chemical News*, 1924, CXXVIII, 64). The most noteworthy feature of Dr. Peklo's book was the reproduction of Kruis' remarkable photomicrographs taken with the aid of ultra-violet light, using silica lenses. These have since attracted some attention in this country.

Dr. Simek's book in the same series deals with an entirely different branch of science, and is a translation of Dr. A. S. Russell's *Introduction to the Chemistry of Radioactive Substances* (Murray, 1922), a review of which appeared in the *Chemical News*, Vol. CXXI., p. 353.

The translator has closely followed the matter and arrangement of the original English edition except for some slight alterations necessitated by increased knowledge. It is a matter of some satisfaction for English men of science to note that Dr. Simek selected this work from among the many works in all languages, dealing with radio-activity, for translation for the use of the Czech students at the Masaryk University of Brno.

Dr. Russell's work in the chemistry and physics of Radio-activity are well-known, and his work is especially suited as an intorductory text-book. The translator states that the original edition has been carefully revised by Dr. Russell, so that the Czech translation is quite up to date.

It will be recalled that the Czech Government controls the St. Joachimsthal radium mines, and thus the subject of radio-activity is of considerable importance to the science students in Czecho Slovakia.

Budgets and Visible Commercial Balances of European Countries, 1922-1925.

This is Bulletin No. 7 issued by the American Library, in Paris, and in its 40 pages are crammed the national balance sheets of the various European nations (a financially sick lot, most of them).

In the majority of cases, there are persistent adverse balances, and in most of the others the incomes and outgoes are just made to balance. Of course no account is taken in an impartial work of this nature of the investments of the various nationals in other countries, or other invisible assets, but these are, in a majority of the nations, of little account. Without doubt, Great Britain would come out on top in the important matter of invisible assets, and no doubt these, if thrown into the scale, would well turn it in Great Britain's favour in the national balance sheet.

First on the list is Austria, with an income in 1925 of 856,855,932 schillings, and an outgo of 914,462, 436 schillings, shewing an adverse balance of 57,606,500 schillings. *The value of the schilling is about 7d.*

Belgium's adverse balance is 772,535,384 francs, while Bulgaria makes a pretence of balancing its accounts to the very leva (value, .071 of a halfpenny). France shews a small surplus of 13,664,060 france, while Germany shews a balance on the wrong side of 254,946,057 Reichsmarks.

When the old countries come out so badly in most cases, it is not to be expected that the new countries formed out of disintegrated Russia and Austria would present anything but a deplorable financial aspect. Probably a more appropriate title for the work would be "The Condition of the Financially Sick Nations of Europe." The pamphlet would be improved by the inclusion of an index, and its value very much enhanced by the addition of another column giving in each case the aggregate equivalent value in English £'s or American dollars, of the figures now given in the currencies of the respective countries. With these reservations, it can be said that the work is handy and valuable, a *multum in parvo* of European finances.

Readers requiring information and advice respecting Patents and Trade Marks will receive the same free from Rayner & Co., Patent Agents, 5, Chancery Lane, London, W.C.2.

FORTHCOMING EVENTS.

THE ROYAL SOCIETY.

Thursday, February 4, at 4.30 p.m.

THE INSTITTION OF ELECTRICAL ENGINEERS.

Wireless Section Meeting, Wednesday, February 3, at 6 p.m. (Light refreshments at 5.30 p.m.) "The Propagation of Electric Waves." By J. Hollingworth, Associate Member.

ROYAL SOCIETY OF ARTS.

Monday, February 1, 8 p.m. (Cantor Lecture.) H. P. Shapland, A.R.I.B.A., late Editor of the *Cabinetmaker*, "The Decoration of Furniture." (Lecture III.)

Wednesday, February 3, 8 p.m. (Ordinary Meeting.) Sir Edward John Russell, O.B.E., D.Sc., F.R.S., Director, Rothamsted Experimental Station, "Investigations in Agricultural Science at Rothamsted." The Rt. Hon. Lord Clinton, Chairman, Lawes Agricultural Trust, will preside.

ROYAL INSTITUTION OF GREAT BRITAIN.

Tuesday, February 2, at 5.15 p.m. "Surface Action," by Eric K. Rideal, M.B.E., D.Sc.

Thursday, February 4. "Who Were the Greeks?" By John L. Myres, O.B.E., D.Sc.

Friday, February 5. "Shakespeare's English." By George Garden (Merton Professor of English).

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

The Ordinary Monthly Meeting of the Society will be held immediately following the Annual General Meeting, when the following papers will be read :—

"The Determination of Copper in Vegetables." By L. H. Lampitt, D.Sc., F.I.C., and E. B. Hughes, M.Sc., F.I.C.

"Arsenic in Apples." By H. E. Cox., M.Sc., Ph.D., F.I.C.

"*The Titration of Thallous Salts by Potassium Iodate.*" By A. J. Berry, M.A.

"The Hot Springs at Nasavusavu." By C. H. Wright, M.A., F.I.C.

Feb. 1926.

Mon. 1.—Society of Chemical Industry. (L.S.)

Wed. 3.—Society of Public Analysts.

Thur. 4.—Chemical Society.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

505.—Coley, H. E.—Manufacture of barium sulphide and barium hydroxide. January 7th.

507.—Coley, H. E.—Reduction of sulphates. January 7th.

299.—L. G. Farbenindustrie Akt-Ges. —Production of phosphoric acid. January 5th.

183.—Lilly & Ci., E.—Process of obtaining antitoxins, etc. January 4th.

Specifications Published.

244,895.—Badische Anilin & Soda Fabrik. —Manufacture and production of carbonyl compounds.

244,924.—Singh, P., and Majithia, S. K. S. —Process for the refining of saccharine liquids.

244,951.—Dickens, C.—Chemical product resulting from a reaction between barium and a metal of the sulphur group, and its method of manufacture.

234,074.—Rhodin, B. E. F.—Process for extracting or refining magnesium.

Abstract Published.

243,192.—Superphosphate.—Hyde, A. C., Perivale Lodge, Perivale, Ealing, London.

Calcium superphosphate is made by mixing finely ground calcium phosphate in the form of a dust cloud with a fine spray of sulphuric acid which may be of 1.84 specific gravity or somewhat weaker. The product is usually sufficiently dry to be packed into bags, but when a weaker acid is used, some drying may be necessary. The temperature employed may be above or below normal.

The Latest TRADE MARKS

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THE CHEMICAL NEWS,
VOL. CXXXII. No. 3434.
MERTON HOUSE, SALISBURY SQUARE,
LONDON, E.C.4.
TELEPHONES :
Administrative : Central 6521.
Printing Works : Hop 2404.

THE STRUCTURE OF LEAD.

By HAWKSWORTH COLLINS, B.A. (Camb.).

In the *Chemical News*, 1920, CXXI., 244, the constitution of Pb was given for fundamental reasons as $Ca_4Na_2 = Cu_2Ca_2$. It is especially connected with Ca in mineralogy as its ultimate matrix is limestone.

This constitution will now be proved to be correct quite independently by means of the laws of relative volume and heat of formation; i.e., by means of two series of facts, S.G., and H.F., which are absolutely independent of one another and of the facts which were originally employed to discover the constitution of Pb.

TABLE I.

The Relative Volumes of Lead.

(1) $Pb(206) = Ca_4(160) + Na_2(46)$
(2) $19.44 = 4(3.91) + 2(1.9)$
(3) $Pb(206) = Cu(63) + Cu(63) + Ca(40) + Ca(40)$
(4)aq. $20.18 = 5.23 + 7.13 + 3.91 + 3.91$
(5) $18.17 = 7.13 + 7.13 + 3.91 + 0$
(6) 17.42
(7) 19.81
(8) 20.45

Since Cu = NaCa, (1) and (3) are identical.

5.23 and 7.13 have been shown to be volumes of Cu as a separate element and also when forming a constituent part of thallium. 1.9 (Na) has frequently been shown to be a constituent part of other elements . It is now necessary to demonstrate that 3.91 has a structural meaning which shows that it is undoubtedly a volume of Ca when forming a constituent part of another element. For this purpose the experimental data in Table II. are required for demonstrating the results of Table III.

TABLE II.

	Relative Volume	Theor S.G. at 15° C.	Obs. S.G.	
(9)	Mo 9.44	10.17	10.12 - 10.32	International
(10)	MoC 9.44 + 3.44	8.4	8.4	20° Nostrand
(11)	C(diamond) 3.44	3.49	3.49	Grailich
(12)	Co 6.78	8.702	8.71	Lampadius
			8.558	Henry
(13)	U_2C_3 2(21.59) + 3(0.71)	11.30	11.28	18° Nostrand
(14)	UO_2 21.59 + 2(2.51)	10.15	10.15	Ebelmen
(15)	UBr_2 21.59 + 4(23.09)	4.86	4.84	21°/4 Nostrand
(16)	Fe_6Si_2C 6(6.4) + 2(7.13) + 8	6.66	6.6	Colson
(17)	MnSi 6.94 + 7.13	5.90	5.90	15° Nostrand
(18)	$MnSi_2$ 6.94 + 2(7.13)	5.24	5.24	13° Nostrand
(19)	MnB_2 6.94 + 2(2.9)	6.04	6.04	19° Nostrand
(20)	FeB 6.4 + 2.9	7.2	7.15	18° Nostrand
(21)	Fe_3C 3(6.4) + 5.69	7.23	7.07	16° Nostrand
			7.396	International
(22)	C (graphite) 5.69	2.11	2.105	Mené
			2.14	Fuchs
(23)	$FeAs_2$ 6.4 + 2(11.38)	7.07	7.40	Hillebrand
			6.246	Behncke
(24)	Bi_3As_4 3(21.29) + 4(11.38)	8.47	8.45	Descamps

TABLE III.

(25)	Fe	=	Si_2	=	6.4	=	3.2	+	3.2
(26)	Ca	=	SiC	=	3.91	=	3.2	+	0.71
(27)	Mn	=	SiAl	=	6.94	=	3.2	+	3.74
(28)	Co	=	S.Al	=	6.78	=	3.04	+	3.74

(29)	Mo	=	Na_3Al	=	9.44	=	3(1.9) +	3.74
(30)	Mg	=	C_2	=	8.71	=	8 +	0.71
(31)	Ca	=	SiC	=	12.24	=	11.53 +	0.71
(32)	Ca	=	SiC	=	14.54	=	13.83 +	0.71

It is evident from Tables II. and III., that 3.2 is a volume of Si, and 0.71 a volume of C; so that 3.91 is reasonably a volume of Ca (= SiC).

In addition to these facts, 8.0 and 0.71 were shown to be volumes of carbon in hundreds of organic molecules sent to the Nobel Institute in 1914. The four volumes of C herein concerned are quite distinct and definite; 3.44 as diamond, 5.69 as *graphite, 0.71 as the form when each valence is united to a separate element* in organic molecules, 8.0 when two or three valences are united to the same element.

11.53 and 13.83 were shown to be volumes of Si in *The Chemical News*, 1924, CXXIX., 48.

TABLE IV.

Experimental Data Illustrating Table I.

	Relative Volume.	Theor. S.G. at 15° C.	Obs. S.G.	
(33)	$PbCl_2$ 19.44 + 2(15.085)	5.58	5.68	Karsten
			5.29	Monro
(34)	PbI_2 19.44 + 2(27.75)	6.14	6.12	Rodwell
(35)	$Pb(C_2H_3O_2)_2$ 19.44 + 2(40.22)	3.24	3.238 - 3.264	Schroder
(36)	$PbBr_2$ 19.44 + 2(18.06)	6.59	6.61	18° Kremers
			6.572	19°.2 Keck
(37)	$PbSeO_4$ 19.44 + 36.35	6.238	6.23	18° Pettersson
(38)	$PbSeO_4$ 19.44 + 35.21	6.37	6.37	22° Schafarik
(39)	$PbWO_4$ 19.44 + 21.59 + 7.53 + + 3(2.51)	8.1	8.1032	Kerndt
(40)	$Pb_5V_3O_{12}Cl$ 5(19.44) + 3(17.76) + 3(7.53) + 9(2.51) + 15.085)	6.7	6.707	12° Roscoe
(41)	Pb 18.17	11.34	11.33	Kupfer
			11.346	Crichton
(42)	PbAs 18.17 + 11.38	9.51	9.55	Descamps
(43)	$PbBr_2$ 18.17 + 2(18.06)	6.74	6.67	25°/4 Nostrand *i.e.*, 6.7 15°
(44)	Pb_3Sn 2(18.17) + 16.02	10.43	10.421	Calvert
(45)	Pm_3Sn 3(18.17) + 16.02	10.12	10.11	Riche
(46)	Sn 16.02	7.37	7.373	Deville
(47)	PbO 17.42 + 7.53	8.90	8.74 - 9.09	Geuther
(48)	$PbCl_2$ 17.42 + 2(15.085)	5.82	5.805	15° Stolba
			5.873	18°/4 International
(49)	PbS 17.42 + 15.53	7.22	7.25	Chem. Kal.
			6.92	Playfair and J.
(50)	$PbSO_4$ 17.42 + 30.59	6.292	6.298	Mohs
(51)	PbClBr 17.42 + 15.085 + 23.09	5.76	5.741	Iles
(52)	$PbCl_4$ 17.42 + 4(23.01)	3.18	3.18	0° Chem. Kal.
(53)	Pb_3As_2 17.42 +2(19.44) + 2(11.38)	9.71	9.76	Descamps
(54)	Pb formate 17.42 + 2(23.8)	4.552	4.56	11° Bodeker
(55)	PbI_2 17.42 + 2(27.75)	6.31	6.384	Filhol
(56)	PbC_2O_4 17.42 + 2(8) + 3(7.53) + 2.51	5.024	5.035	Schroder
(57)	PbTe 17.42 + 23.74	8.115	8.159	Rose
			8.06	Genth
(58)	Pb acetate 19.81 + 2(40.22)	3.232	3.238	Schroder
(59)	$PbCO_3$ 19.81 + 8 + 7.53 + 2(2.51)	6.59	6.60	Smith
			6.5	John
(60)	PbN_2O_6 19.81 + 2(3.8) + 6(7.53)	4.546	4.581	Filhol
			4.509	Schroder

(61)	$PbSO_4$ 19.81 + 30.59	5.09	5.97 6.16	18° Pettersson Gorgeu
(62)	$PbC_2N_2S_2$ 19.81 + 2(0.71 + 16.02 + 15.53)	3.82	3.82	Nostrand
(63)	$PbBr_2$ 19.81 + 2(18.07)	6.541	6.572	19°.2 Keck
(64)	PbO_2 19.81 + 2.51 + 4.45	8.88	8.756 - 8.897	Playfair & Joule
(65)	PbTe 20.45 + 20.55	8.15	8.159 8.06	Rose Genth
(66)	PbI_2 20.45 + 2(27.75)	6.06	6.07 6.0212	Schiff Karsten
(67)	$PbS.Bi_2S_3$ 20.45 + 15.53 + 2(21.29) + 3(10.51)	6.83	6.88	Sjogren
(68)	$2PbS.Bi_2S_3$ 2(20.45 + 15.53) + 2(21.29) + 3(10.51)	6.77	6.75	Dana
(69)	Bi_2S_3 2(21.29) + 3(10.51)	7.0	7.0001	Karsten
(70)	$PbAgI_3$ 20.45 + 13.29 + 3(27.75)	5.93	5.923	0° Rodwell.

TABLE V.

	Heat of Formation of Pb.	Original Volume		Rel. Vol. in combination at 15° C.		Change of Volume
(71)	18500 = 120 × 0.75 × 206	18.17	=	17.42	+	0.75
(72)	-31394 = 120 × (-1.27) × 206	18.17	=	19.44	-	1.27
(73)	-40607 = 120 × (-1.64) × 206	18.17	=	19.81	-	1.64
(74)	aq. -49735 = 120 × (-2.01) × 206	18.17	=	20.18	-	2.01
(75)	-56362 = 120 × (-2.28) × 206	18.17	=	20.45	-	2.28

TABLE VI.

Experimental Data Illustrating Table V.

	Heat of Formation.		Theor.	Obs.	
(76)	Pb.O 18500 + 32341	=	50841	50800	
	(corresponds with No. 47)				
(77)	Pb.S 18500 + 0	=	18500	18420 20300	
	(corresponds with No. 49)				
(78)	Pb.Se 18500 - 1928	=	16572	17000	cryst.
(79)	$Pb.Cl_2$ - 31394 + 2(56786)	=	82178	82770 83900	
	(corresponds with No. 33)				
(80)	$Pb.I_2$ - 31394 + 2(36227)	=	41060	41850 39800	
	(corresponds with No. 34)				
(81)	$Pb.H.P.O_3$ -31394 - 15300 + 8593 + 71515 + 2(96155)	=	225724	227700	
(82)	$Pb.O_2$ - 31394 + 2(32341)	=	33288	36400	
(83)	$Pb.S.O_4$ - 40607 - 0 + 2(32341 + 96155)	=	216385	216210	
(84)	$Pb.C.O_3$ - 40607 - 13855 + 32341 + 2(96155)	=	170189	170000	
	(corresponds with No. 59)				
(85)	$Pb.N_2.O_4$ - 40607 - 2(23300) + 6(32341)	=	106839	105460	
	(corresponds with No. 60)				
(86)	$Pb.O_2.N_2O_4$ - 40607 + 2(32341) + 85332	=	109407	108110	
(87)	$Pb.C_2.N_2.S_2$ - 40607 - 2(4425) - 2(1575) + 2(30681)	=	8755	6100	

(88)	Pb.Te - 40607 + 46130	=	5523	6200	
(89)	Pb.O_2 - 40607 + 32341 + 71515	=	63249	62400	
(90)	aq.Pb.N_2.O_6 - 49735 - 2(23300) + 6(32341)	=	97711	97850	
(91)	aq.Pb.O_2.N_2O_4 - 49735 + 2(32341) + 85332	=	100279	100500	
(92)	aq.Pb.O.N_2O_5 - 49735 + 32341 + 85332	=	67938	68070	
(93)	aq.Pb.Br_2 - 49735 + 2(52930)	=	56125	54410	
(94)	aq.Pb.Cl_2 - 49735 + 2(63870)	=	78005	77100	
				75970	
(95)	aq.Pb.O_2.SO_2 - 49735 + 2(96155)	=	142575	145130	
(96)	aq.H.Cl - 24350 + 63870	=	39520	39315	T
(97)	liq.H_2.O - 2(24350) + 117460	=	68760	68360	Thomsen
				69000	Berthelot
(98)	cryst. H'_2.O - 2(15300) + 96155	=	65555		
(99)	aq.H.I - 24350 + 37720	=	13370	13170	T
(100)	Zn.C_4.H_6.O_4 - 14900 + 2(140086)	=	265272	267400	
(101)	aq.H_2.S.O_4.H'_2O - 2(24350) + 6217 + 2(32341 + 96155) - 3205	=	211304	210770	T
(102)	aq.H.N.O_3 - 24350 - 23300 + 3(32341)	=	49373	49090	T
(103)	Acetic acid - 24350 + 140086	=	115736	117200	Cleveland
				105290	Thomsen
(104)	aq.K.Cl 37274 + 63870	=	101144	101170	T
(105)	aq.K.I 37274 + 37720	=	74994	75020	T
(106)	aq.K.N.O_3 37274 - 23300 + 3(32341)	=	110997	110700	

Heat of Neutralisation.

When (76) and twice (96) form (97) and (79), with complete precipitation of $PbCl_2$,

32341 becomes 117460
2(63870) becomes 2(56786)
18500 becomes - 31394

(107) 117460 - 32341 - 2(63870) + 2(56786) - 18500 - 31394 = 21057 22190 Thomsen

When (76) and twice (99) produce (97) and (80),

32341 becomes 117460
2(37720) becomes 2(36227)
18500 becomes - 31394

(108) 117460 - 32341 - 2(37720) + 2(36227) - 18500 - 31394 = 32239 31520 T

When (76) and twice (96) produce (94) and (97), with no precipitation of $PbCl_2$,

32341 becomes 117460
18500 becomes - 49735

(109) 117460 - 32341 - 49735 - 18500 = 16884 15390 T

When (76) and (101) produce (83) and twice (97),

6217 becomes 0
32341 becomes 117460
18500 becomes - 40607
- 3205 becomes 0

(110) - 6217 + 117460 - 32341 - 40607 - 18500 + 3205 = 23000 23380 T

When (76) and twice (102) produce (90) and (97),

32341 becomes 117460
18500 becomes - 49735

(111) 117460 - 32341 - 49735 - 18500 = 16884 17770 T

Heat of Decomposition.

When Lead acetate and Zn produce zinc acetate and Pb,

− 49735 becomes 0

0 becomes − 14900

there being no change in the acid radicle.

(112) 49735 − 14900 = 34835 34950 T

When (90) and twice (104) produce (79) and twice (106),

− 49735 becomes − 31394

2(63870) becomes 2(56786)

(113) 49735 − 31394 − 2(63870) + 2(56786) = 4173 4460 T

Summary.

The six volumes of Pb given in Table I. are all distinct and definite, although at first sight they may appear to be too close to one another to be easily distinguishable. Fortunately, the H.F. is particularly susceptible to any small change of volume, since the latter has to be multiplied by such large numbers as the constant 120 and the at. wt. 206; *i.e.*, the change of volume has to be multiplied by 24720 (= 120 × 206). This large multiplier places the results of Table V. completely outside any possibility of accident. Four of the five values obtained for the H.F. of Pb are supported in Table VI. as exactly as can possibly be expected by experiment. The fifth value is not corroborated because it happens that none of the direct experiments made by Thomsen contained an atom of Pb with the volume 20.45, although it is one of the commonest forms of the element.

The fact that three of the volumes of Pb in Table I. have not yet been split up in the usual manner in accordance with the law of relative volume, need cause no anxiety; because there is no reason for supposing that all constituent volumes have been discovered. Each of these volumes is supported by a large number of experimental facts, and therefore must be correct. In particular the vol. 20.45 is exactly supported by a great many more than the five facts numbered 65 to 70 ,for which alone room can be found in this paper.

Each numbered line of figures in this and the preceding (about 20) papers, contains a new relation between observed facts; *i.e.*, contains a discovery. And, if in the future any one is found to be wrong, the others will not be affected in the slightest.

It could be shown, as in preceding papers, if space allowed, that each volume in Table I. is correct for many independent reasons; and also that in addition to demonstrating the constitution of Pb, this paper accomplishes several other objects.

The intricate interdependence of 113 facts herein demonstrated, which is exactly similar to that of the facts with regard to the 20 other elements previously given, makes it absolutely certain that the correct constitution of an atom of lead has been obtained.

AIR BUBBLES IN THE DRAUGHT TUBE OF A WATER TURBINE.

By Otogoro Miyagi—*Kōgakuhakushi.*

Abstract.

Owing to low pressure in the draught tube of a water turbine, air may leak into it from the outside in the form of bubbles through the joints or packings or through the concrete lining in a badly constructed concrete draught tube. Some of them are carried off with the water while others rise opposite to the flow and accumulate in the upper part of the tube, and are expelled periodically down into the tail race. The head lost due to the bubbles is calculated.

The writer's recent experiments have shown that a bubble of a given size has a fixed velocity of rise in still water, and the velocity w in cm. per sec. of a bubble, the radius of which is r cm., assuming a spherical bubble, is determined by solving the following quadratic equation.

$$(2.07r^2 - 0.211r - 0.000282)w^2 + (15.1 - 205r)r^{\frac{3}{2}}w + 410r^3 = 0 \ . \ . \ . \quad (1)$$

The velocity of a bubble the radius of which is less than about 0.12 cm. increases

approximately linearly with its size; it is maximum and equal to about 27.8 cm. per sec. for a bubble of the radius of 0.165 cm.; then it decreases nearly parabolically with their sizes: and then it tends to have constant velocity of about 23 cm. per sec. irrespective of the size.

(*Tohoku Imperial University.*)

AGRICULTURE AND CHEMISTRY IN SOUTH AFRICA.

Chemistry is taking a prominent part in the development of the agricultural resources of South Africa. This is shewn clearly in the Annual Report of the Department of Agriculture, Union of South Africa, published in the December issue of the Journal of the Department, just to hand. The Acting Chief of Division is Dr. St. C. O. Sinclair, M.A., F.I.C.

1. *Organisation.*—During the year the Division performed chemical work—routine and investigational—for the several departments of the Union Government, with the exception of the Division of Veterinary Education and Research, which has its own chemical staff at Onderstepoort.

To carry out its functions the Division has (1) three series of laboratories—one at Pretoria, one at Johannesburg, and one at Cape Town; (2) a senior chemist, stationed at the Grootfontein School of Agriculture, Middelburg (Cape Province), who, in addition to his own staff, had the partial services of the chemical staff of the school and the use of the laboratory attached to that institution; (3) the partial services of the staffs of the chemistry sections of the five Schools of Agriculture. The chemical work of the Pretoria Laboratory was agricultural, and that of Johannesburg virtually non-agricultural.

2. *Staff.*—In order to enable the Division to cope to some extent with the constantly increasing work in connection with the Union soil survey and irrigation schemes, two additional technical officers—Dr. M. M. S. du Toit, B.A., and M. F. E. A. Leibrandt, M.A.—were appointed during the year and stationed at the Grootfontein School of Agriculture under the control of the senior chemist there.

In March, 1925, the Chief of the Division, Dr. Chas. F. Juritz, M.A., F.I.C., retired on pension, and Dr. St. C. O. Sinclair was appointed Acting Chief.

The office of the Chief of Division, which had hitherto been located in Cape Town, was removed to Pretoria. Mr. Stead, M.Sc., F.I.C., the senior chemist at Grootfontein, and his staff were transferred to the Pretoria laboratory, Dr. B. de C. Marchand, B.A., till then senior chemist at Pretoria, being transferred to Cape Town as officer in charge of the Government Chemical Laboratories there.

Research work, such as soil investigations, soil innoculation, citrus investigations, fumigations, sulphuring of dried fruit, cotton-growing and manurial experiments, various investigations connected with farming, fertilisers, foods, Customs and excise work, forensic work, etc., help to make up a full and useful year's work on the part of the staff. The following are exracts from Reports of the Division's Officers in Charge at Johannesburg, Cape Town, Pretoria, and Middelburg (Cape).

Johannesburg. J. McCrae, Ph.D., F.I.C., Assistant Chief of Division.—The aggregate number of samples examined during the year was 5,148, including 289 samples of gold and gold-bearing materials, 1,475 food samples, 586 wines and spirits and vinegars, 273 explosives, 342 leathers and leather preparations, 267 waters and 98 samples of liquor in connection with illicit liquor selling cases, 246 drugs and medicines, and 305 exhibits in cases of human and animal poisoning.

Cape Town. B. de C. Marchand, B.A., D.Sc., Senior Chemist.—The total number of samples dealt with was 3,365. These included 1,753 examined under the Sale of Food and Drugs Act (Cape); 803 for the Department of Agriculture, consisting mainly of fertilisers, wines, spirituous liquors, and vinegars; and 431 for the Customs and Excise Department, comprising analyses of leathers and other articles for tariff classification, as well as that of spirituous preparations — medicinal, pharmaceutical, and toilet—for excise purposes. The research work of the laboratories included the investigations relating to the composition of citrus and other fruits, the composition of South African honey, and the effect of Cape Town water on locomotive boilers.

Grootfontein. A. Stead, M.Sc., F.I.C., Senior Chemist.—During the year, 622 written communications were received and 453 dispatched over and above the correspondence dealt with on behalf of the School of Agriculture. Work in connection with

the Union soil survey as well as various irrigation projects war carried out, and several lectures given at farmers' association meetings and farmers' weeks on soil problems connected with irrigation, veld improvement, animal nutrition, etc. It is worthy of record that the saaidam terrace system inquired into by the Senior Chemist has now been recommended to farmers not only as an agricultural resource, but as a means of minimising the silt problem in dams.

PRETORIA. A. Stead, M.Sc., F.I.C., Senior Chemist.—During the year, 235 samples were examined, 166 of which represent soil samples taken in connection with various investigations. The research work carried out in the Institution included (1) the determination of the effects of varying quantities of water on the growth of oats in two widely differing types of soil; (2) an investigation into the composition of the fractions separated by mechanical analysis from some Transvaal soils; and (3) percolation experiments with black turf soil, using solutions of calcium nitrate of varying strengths. A large number of freezing-point determinations were also made in connection with an inquiry into the alterations of the freezing point brought about by successive freezing of soil and the addition of certain substances. Standardisation of dairy glassware was also undertaken, the total number of pieces dealt with being 1,390.

Trade and General Notes.

CANADIAN MINERAL PRODUCTION IN 1925 EXCEEDS ALL PAST RECORDS.

Great progress was made in Canada's mineral industry during 1925 and metal mining particularly experienced a boom which carried prodnction in this field far above all previous records. The total value of the mineral production of the Dominion is calculated at $228,440,000, an increase of $18,857,000 above the total of $209,583,406 for 1924, and more than the previous record of $227,859,665 attained in 1920, when metal prices were approximately 85 per cent. higher than in the year just closed.

Among the metals, the remarkable advances in the production of gold, lead and zinc were most outstanding; improvement in outputs marked the totals for nickel, copper, and cobalt; silver showed little change; there was an increase in the tonnage of iron ore exported from stocks at the mines.

CANADIAN JOINT STOCK COMPANIES.

The aggregate capital invested in Canada in joint stock companies amounts to 3,642,276,628 dollars, of which Canadians hold 60 per cent., United Staters 28 per cent., Britishers 9 per cent., and inhabitants of other countries 3 per cent.

CANADIAN TRADE WITH THE UNITED KINGDOM AND UNITED STATES.

The Dominion Bureau of Statistics, Ottawa, in a report on the Trade of Canada, states that imports for consumption from the United Kingdom and the United States during the twelve months ended 30th November, 1925, amounted to 160,674,262 dollars and 570,446,325 dollars, while exports of Canadian produce to those countries during the same period totalled 459,075,372 dollars, and 479,927,202 dollars respectively.

GROWING U.S.A. TRADE.

During 1925 the pig iron manufactured amounted to 36,403,470 tons as compared with 31,108,802 tons for 1924. Steel ingots amounted to 44,186,977 in 1925, as compared with 36,811,157 tons in 1924.

DEVELOPING CHEMICAL INDUSTRIES IN CANADA.

The Aluminum Company, at its new town site of Arvida, in the Lake St. John district of Quebec, has commenced the erection of a number of houses to accommodate the workmen engaged on their new development. The company expects to employ from seven to eight thousand hands as soon as the plant is in operation. It is understood that apart from the aluminium plants, some subsidiary of the company will arrange to manufacture fertilising preparations that are in great demand for the growing of tobacco in Canada and the United States.

Ochres, wad and ferruginous clays suit-

able for the manufacture of paint and hydrated oxides of iron for the purification of illuminating gas, are found in many parts of Canada.

PULP FOR FIBRO SILK.

The development of the fibro silk industry has had a remarkable influence upon the development of Canada's sulphite pulp industry. The great demand for bleached sulphite has created an exceptionally active condition on this branch of the pulp and paper industry, and many mills are feeling the benefit. The Kipawa Mill, of the International Paper Company, formerly of the Riordan Company, has been turning out bleached sulphite pulp for fibro silk for some time, following a long period of experiment, and so great has been the success that an extension of the plant has been decided upon. The market for this fibre silk pulp has until recently been divided between the United States and Europe, but the commencement of operations by the Courtauld Company, or Cornwall, Ontario, will create a Canadian market for this product.

NITROGEN FROM THE AIR.

U.S.A. Department of Agriculture chemists have, it is stated, solved the problem of obtaining cheap synthetic ammonia from the air, which, if true, is bound to have far-reaching results on industry, and notably agriculture, and also the manufacture of explosives.

BRITISH FIRM'S WORLD-WIDE SUCCESS.

How the building of one tiny prism of glass on another has enabled a British firm to win a world-wide market for its products lies behind the announcement that by the contracts they have secured in the New Year, the Holophane Company have brought the number of towns using their lighting system to 500.

The new contracts are two for South America—one of 10,000 pieces for Santiago in Chile and another of 1,000 pieces for Buenos Ayres—and one of 3,000 pieces for the Borough of Hackney, representing a total value of several thousand pounds sterling.

But more eloquent than the monetary value of these contracts is the list of towns using this system of scientific street lighting.

Holophane installations are in use in no fewer than 17 different countries in the world and in 298 cities of the United States alone. Just before Christmas, the contract for the lighting of the City of Milwaukee was secured at a value of £17,000.

A WONDERFUL NEW LEATHER FABRIC.

The oft-repeated accusation that British brains in industry are not what they were seems to be in part rebutted by the invention of a young Scottish chemist who has not only found a process for regenerating leather waste, but has managed to market the product in the U.S.A.

According to the description of its inventor, his process is " a means of regenerating leather and other substances," and the product, which is called " Ceymal," is hardly distinguishable from real leather, and is about half the price of hides.

The inventor has not patented his process, prefering to keep it a secret known only to himself. The leather is first ground into a fine powder and any impurities removed. To this is added a small quantity of binding substance, which has the effect of binding the leather into a tough dough. This, together with the colouring mixtures, is milled until the whole becomes a homogeneous mixture. It is then calendered on to a backing cloth, which is great strength.

SWINDLING TRICKSTERS FOILED BY EXCHANGE OF CREDIT INFORMATION.

SUCCESSFUL F.B.I. SCHEME.

Over 1,500 firms are now participating in the scheme for an exchange of credit information which was recently instituted by the Federation of British Industries.

This scheme, which aims at giving prior and automatic warning of undesirable traders or firms who are consistently and wilfully slow in payments, and which has only been in operation fourteen weeks, has just been extended to all members of the Federation, and now covers every important trade in the country. Already the number of names of undesirable traders which has been circulated to participants has reached over 800, a total which is increasing at an average of 80 a week, 40 per cent. of which are foreign defaulters coming from over 40 different countries throughout the world.

So far, the working of the scheme has disclosed interesting information as to the commonest type of fraud practised on industry, a list of which appears below. In each different case, the scheme has provided a certain insurance against a repetition of the deception.

1.—*Hidden Assets.*—A man declares he is unable to pay as he has nothing on which to levy, having previously made over his assets to his wife or to some near relative. This is the commonest type of fraud. The Federation has already had one instance of a man who played this trick with four separate trades within six weeks. The scheme, however, speedily shows up these cases, and a man is either forced to pay or to go to gaol.

2.—*Long Firm Frauds.* — This well-known method of obtaining goods, selling them to sources which cannot be traced, and then decamping, is the next commonest type of fraud. Under the F.B.I. scheme, however, as information comes from every trade, all the aliases of the fraudulent trader rapidly become known, with the result that all his sonrces of supply are eventually cut off. That is, of course, so long as he approaches only members of the F.B.I. who are participating in the scheme.

3.—*Refusal to Accept Delivery.*—This is a common type of foreign fraud, and consists in a buyer ordering goods, getting them sent to a foreign market, and then refusing to accept them, afterwards buying them in at " knock-down " prices at public auction.

4.—*Obtaining Samples and Selling Them.*—This fraud consists in obtaining a large range of expensive samples from firms and of selling them without any attempt to obtain orders and is met with both in Great Britain and abroad.

5.—*Default on Large Orders.*—A common trick is for a firm to put through two or three small orders, for payments is made promptly, and then to order a large quantity of goods and default and very often decamp.

6.—*Obtaining by Trickery, Orders for Larger Quantities than the Buyer Wishes to Take.*—This is commonly met with among foreign firms. The usual method is to press for a small sample order to be placed. By a trick, a signed order is obtained which makes the firm ordering the sample liable for a large bulk consignment. Various methods are adopted. Sometimes an order form in a foreign language is placed before the bnyer, sometimes the cashier is instructed to write, and again, sometimes the engineer-in-charge is asked to initial a form at " the instruction of his director." The result is the same in either case, and the victim is liable for pounds instead of shillings.

7.—*Querying Quality of Goods Ordered.*—It frequently happens that a purchaser will, months and sometimes years after payment is due, query the quality of the goods sent to him. In one case which has come to the notice of the F.B.I. the excuse that the goods were not np to standard was only made two years after the delivery of goods.

8.—*Agents on Commission Doubling Orders.*—A very widespread type of fraud is that in which an agent on commission doubles the order from a client. He receives a commission on the total order, but if, when the goods are delivered, he finds he is unable to sell the extra quantity he ordered on his own account, he repudiates the transaction and defaults.

EXPORTS OF BRITISH MACHINERY.

Commenting on the Board of Trade Returns, the British Engineers' Association points out that some of the most satisfactory figures are those relating to the exports of machinery, motor cars, locomotives and electrical apparatus. The total of exports of machinery for December (47,744 tons) is not only the highest monthly total recorded last year, but is higher than that of any month dnring the past three years. The total exports of machinery for the year 1925 amounted to 515,896 tons—the highest figure for any year since 1913.

Without undue optimism, it may therefore be maintained that the steady tendency to improvement recently reported by the Association is generally confirmed by these statistics. It should not be forgotten, however, that the total export tonnage of machinery still represents only 75 per cent. of the pre-war average, and that there is still considerable leeway to be made up, bnt, given favourable conditions and no acute labour disturbances, it may reasonably be anticipated that the results for the ensuing year will show further and progressive improvement.

DRUGS, SERUMS, AND PHARMACEUTICAL SPECIALITIES IN TURKEY.

The *Journal of the British Chamber of Commerce in Turkey* for January gives a list of the specialities the entry of which has to date been authorised by the Government under the Regulations concerning the import and sale of pharmaceutical specialities, drugs, serums, and vaccines.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read in title at the meeting on January 21, 1926.

The Soft X-ray Absorption Limits of Certain Elements. By URSULA ANDREWES, ANN C. DAVIES AND F. HORTON, F.R.S.

Investigations have been made of the voltages corresponding to critical values of electron energy associated with some of the longer wave-length absorption stages of seven successive elements, Cr, Mn, Fe, Co, Ni, Cu and Zn. The following values, in volts, have been obtained :—

Cr		60	70		143	160	173
Mn		68	83	100	152	174	184
Fe	47	73	90	106	166	181	
Co			94	113	171	191	
Ni			104		178	196	
Cu			112		193	206	
Zn			119		200	214	

The view is put forward, and evidence is deduced to support it from comparisons of measured absorption limits and emission lines, that the generally accepted value of an absorption limit, obtained by spectroscopic methods, corresponds not to ionisation of the atom by the detachment from it of an electron in the sub-group concerned, but to the transportation of the electron from the sub-group to the periphery of the atom, *i.e.*, to the levels of the most loosely bound electrons. For the more deeply seated levels within atoms, the quantity of energy required to move an electron to the periphery probably differs very little from that required to effect its complete detachment from the atom. In the case of levels near the normal boundary of the atom the two quantities may differ considerably, however, giving the possibility of the detection of absorption stages corresponding to transitions to virtual orbits between the periphery and the region at which the electron may be considered to be detached from the atom, and the latter ionised.

Extrapolation of the Moseley curves for the various absorption limits down to low atomic numbers shows that the values obtained in this investigation must be associated with absorption of energy by electrons in the M sub-groups. The several values obtained for each element are attributed to selective absorption stages, resulting in the transference of electrons from the sub-groups associated with the levels M_{I} and $M_{II,\ III}$, to various virtual orbits outside the normally occupied region of the atom, and not to actual ionisation of the atom.

The Crystalline Structure of Chrysoberyl. By W. D. BRAGG, F.R.S., AND G. B. BROWN.

Chrysoberyl, $BeAl_2O_4$, is analogous in chemical composition to the spinel group of minerals $R''R_2''''O_4$ ($MgAl\ O_4$, $FeFe_2O_4$, $ZnAl\ O_4$, etc.). It is entirely different in its crystalline form, being orthorhombic, whereas the spinels are cubic. This investigation has led to the location of the aluminium and oxygen atoms in $BeAl\ O_3$.

These features may be pictured by supposing the oxygen ions to occupy the greater part of the volume in the crystal, and the metal ions to be placed in the interstices between a close-packed assemblage of oxygen ions. A comparison of BeO, Al_3O_3, BAl_2O_4, shows that in each case the oxygen atoms are very nearly in a close-packed hexagonal arrangement and that the distances between atomic centres are almost identical from the three crystals, being about 2.7A. Each aluminium atom in Al_2O_3 and $BeAl_2O_4$ occupies a position between six oxygen atoms. The beryllium atom is so light that it is difficult to locate. Spinel, $MgAl_2O_4$, is known to be composed of an arrangement of oxygen ions which are nearly in cubic close-packing, with each aluminium atom between six oxygen ions and each magnesium atom between four oxygen ions. An analogy therefore exists between $BeAl_2O_4$ and $MgAl_2O_4$, though in the latter case the average distance between oxygen ions is slightly increased by the insertion of the magnesium ion.

The hexagonal close-packed lattice can be referred to orthorhombic axes with

ratios $\frac{\sqrt{2}}{3} : 1 : \frac{\sqrt{3}}{3}$. The correspondence with the axial ratios of $BeAl_2O_4$ is very close.

$$BeAl_2O_4 \quad a : b : c = 0.4707 : 1 : 0.5823$$

$$\frac{\sqrt{2}}{3} : 1 : \frac{\sqrt{3}}{3} = 0.4713 : 1 : 0.5773$$

The analysis has been carried out by measurements made with the ionisation spectrometer, and by rotating-crystal photographs.

On a Set of Quartic Surfaces in Space of Four Dimensions, and a Certain Involutory Transformation. By H. G. TELLING. Communicated by Prof. H. F. Baker, F.R.S.

The surfaces are of the kind which project, into space of three dimensions, into the quartic surfaces known as Cyclides. Each of the surfaces in four dimensions may be generated by taking three arbitrary skew lines and two arbitrary points, drawing a plane through each of the points to meet the three lines, and then finding the locus of the intersection of the plane through the first point with the plane through the second point. The geometry of the surface then suggests the consideration of, in all, fifteen lines, of which that joining the two given points is one; and then passing through an arbitrary given point of the lines. The paper is concerned with determining the intersection of any two of these fifteen surfaces. In general, two quartic surfaces in space of four dimensions would intersect in sixteen points. In the present case, two of the fifteen surfaces, associated with two of the fifteen lines which meet one another, intersect in a conic, passing through the common point of all the surfaces, and in two pairs of coplanar lines all meeting the conic; but two of the fifteen surfaces, associated with two skew lines, meet in four lines, consisting of three lines and their transversal, and in a point other than the point common to all. An interesting involutory transformation of the space of four dimensions is suggested, whereby also the points of any one of the quartic surfaces are arranged in pairs; this gives rise to the remaining common point of the two surfaces in the latter case.

ORGANIC RESEARCH AND X-RAYS.

At the Royal Institution on January 22, Sir William Bragg, F.R.S., delivered an address dealing with the Davy Faraday Laboratory. The main subject was the application of the new X-ray methods to the study of organic substances. This covered a vast range of materials, fats, oils, paraffins, alcohols, dyes, explosives, and so on. The work done was in the main contained in the realm of pure science. The new methods of analysis by X-rays were continually showing promise of useful applications to many industrial problems, but it was desirable that such laboratories as the Davy Faraday and the university laboratories should not allow themselves to be drawn away too far from the problems of pure research. If the latter were neglected, the industrial applications would in the end lose their vitality.

The organic substances were built mainly of carbon, oxygen, hydrogen, and nitrogen, with a sprinkling of other atoms; the carbon being the main pivot of their structure. All the properties of the organic structures were contained in these few elements. What, then, in the first place, were the nature, strength, and arrangement of those ties that bound the carbon atoms together? It was known that the carbon atoms tended to link themselves in long chains, or else to build up structures based on a six-membered ring. One of the immediate objects of research must, therefore, be to find out all details concerning these two forms.

Some most interesting discoveries had been made with respect to the chain-molecules, showing that in fats, greases, and other similar bodies they arranged themselves in layers with the chain perpendicular to the layers. It had recently been found possible to extend the earlier X-ray measurements of length and other dimensions to the study of modification of the simple chains. It was known that differences in their properties could be made by adding side links of various kinds and at various points on the chains, and that these were of profound importance in their behaviour. Recent extension of the X-ray methods had made it possible to weigh the additions and to determine their place, which would surely be of value in the interpretation of their significance in organic structures and elsewhere.

As to the oxygen atom, information of its behaviour in crystal structure was

coming in from various sources. Further knowledge of the structure of quartz, into which oxygen entered largely, coupled with growing knowledge obtained at Manchester University and elsewhere of the structures of ruby, chrysoberyl, and other compound oxides, was helping to make clear its general behaviour. It was to such ways as these that research was gradually making its way into the immense field of the organic substances as displayed especially in their crystal structures.

THE OPTICAL SOCIETY.

At a meeting of the Optical Society, held at the Imperial College of Science, South Kensington, on Thursday, January 21, 1926, Mr. T. Smith, M.A., F.Inst.P., in the Chair, the following papers were presented and discussed.

The Interferometer Patterns due to the Primary Aberrations. By R. Kingslake, A.R.C.S., B.Sc.

In order to obtain a rapid estimate of the quality of a lens by observing its behaviour in the interferometer, it is necessary for the observer to be familiar with the characteristic patterns of the various primary aberrations under various conditions of adjustment. A method is described by which these patterns can be easily calculated for any required case; and series of typical patterns are shown together with actual interferograms for comparison.

A Trichromatic Colorimeter Suitable for Standardisation Work. By J. Guild, A.R.C.Sc., F.Inst.P., F.R.A.S.

The paper describes a trichromatic colorimeter, which is suitable for standardisation work, and it may be employed to obtain the specification of any colour whatever in a form which may be converted if desired to any fundamental basis of specification. The three working primaries of the instrument are obtained by means of filters. The mixing of the primary colours is effected by a periscopic prism which rotates past three stationary sectors. Provision is made for adding any of the primaries to the colour under test, where this may be necessary in order to obtain a match. In this way colours of higher saturation than it is possible to match directly may be dealt with.

A Criticism of the Monochromatic-plus-White Method of Colorimetry. By J. Guild, A.R.C.Sc., F.Inst.P., F.R.A.S.

The author contends that, from the practical standpoint of quantitative colorimetry, hue and saturation are not the fundamental elements of colour quality but must be regarded merely as derivatives of the trichromatic constitution of the colour. Practical and theoretical reasons are advanced to show that whatever may be the advantages of specifying colour quality by hue and saturation there are grave objections to practical methods of colorimetry involving the direct measurement of saturation.

On a New Method of Colorimetry. By J. Guild, A.R.C.Sc., F.Inst.P., F.R.A.S.

The paper describes a new method of determining the quality of a colour, as defined by its position on the trichromatic colour chart, in which only the colour matching properties of the eye are involved. The determination depends on two colour-matches in each of which the test colour is matched by a mixture, in unknown proportions, of a standard colour and a monochromatic colour obtained spectroscopically, a different standard colour being used for the two matches. An instrument is described in which the method is embodied.

A demonstration was given of the "Trans-Lux" Daylight Picture Screen, by Messrs. The Gaumont Company, Ltd.

The screen is of a specially prepared material and is such that a picture projected on to one side of it can easily be seen on the other side, even when the room is fully illuminated by daylight or artificial light. Its use obviates the necessity of darkening a room in order to view projected lantern slides or kinema films.

THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

January Examinations, 1926.—Pass List.

Examination for the Associateship in General Chemistry.

Adams, Frederick William (School of the Pharmaceutical Society and Chelsea Polytechnic Institute); Balmforth, Leonard, B.Sc. (Lond.) (Trained under G. E. Johnson, B.Sc., F.I.C., at the Municipal Technical College, Hull); Blood, John Walter (University College, Nottingham); Riley, Thomas (The University, Liverpool); Shipman, George Eric, B.Sc. (Lond.) (Trained under G. E. Johnson, B.Sc., F.I.C., at the

Municipal Technical College, Hull.
Walton, Thomas (Municipal Technical College, Hull); Walton, Thomas (Municipal Technical School, Blackburn); Winter bottom, Edgar, B.Sc. (Manc.) (The University, Manchester.

NOTICES OF BOOKS.

ADVANCES IN PHOTOGRAPHY.

The British Journal Photographic Almanac, 1926, just published*, is noteworthy for several reasons. This is the 61st year of the publication of this Annual, which gives each year, an account of position and advances in photography, as well as other information useful to the photographer. Those responsible for its production have evidently intended that this issue should attain a very high artistic and scientific level.

Probably the majority of chemists and scientists in general are interested in photography, but it is surprising to learn that there are about three and a half millions of amateur and other photographers in Great Britain. The *B. J. Almanac* caters for them all, but only a comparative few will wade through all the information between its covers. There are many, however, who will consult it from time to time as the need arises.

To give a complete account of its contents even, would not be possible in a review of the book, but the more outstanding features can be briefly indicated.

Recent innovations have brought amateur cinematography within the reach of a wider public, and its extensive development in the near future is foreshadowed in an excellent informative and explanatory editorial article. Another lengthy contribution of merit is entitled " Rational Time Exposure," by J. W. Purkis. It is supplemented by the inclusion of valuable time and temperature tables. Attention may also be directed to the non-staining pyro-soda developer advocated in the *Almanac*.

The " Epitome of Progress " has been reduced this year to some 80 pages. Fewer subjects are referred to, but those that are mentioned have been presented in a clear, if concise manner. Although it is to be regretted that this section has been severely pruned of all reference to advances that are not of distinct influence upon the practice of photography, it must be remembered that the reference section has been augmented and thereby made of more utility.

New matter has also been added in connection with colour photography and with reference to the making of lantern slides. Other additions include special developing formulæ for under exposures, and for subjects of extreme contrasts; tank developers; recent improvements in bromoil procedure and the hyper-sensitising of screen colour plates.

The general reader, too, will find abundant interest if only, to begin with, in the numerous handsome photogravure reproductions of pictures from the Paris Salon of Photography with which this annual celebrates its 61st appearance. Special articles on popular aspects of photography, illustrated reviews of the latest in apparatus, materials and methods, and an abundance of invaluable up-to-date information in the reference and advertisement sections complete a rare photographic feast, very appetisingly prepared. To publish such a voluminous and well-produced annual at all is an achievement; but to publish it at the price of 2s. is a noteworthy achievement.

J. G. F. D.

* *The British Journal Photographic Almanac*, 1926. Ed., George E. Brown, F.I.C. 880 pages. London : Henry Greenwood and Co., Ltd., 24, Wellington Street, W.C.2. 2s. net (paper covers); 3s. net (cloth bound).

Compressibilities of Gases. U.S.A. Burea of Standards. Price 10 cents. per copy.

Fourteen graphs for computing the compressibilities of air, argon, helium, hydrogen, methane, neon, nitrogen, and oxygen, and for computing the volumes delivered from cylinders containing argon, helium, hydrogen, nitrogen, and oxygen at high pressures.

The graphs from Circular No. 279, The Relations Between the Temperatures, Pressures, and Densities of Gases, have been reproduced on a larger scale in order that they may be used for obtaining numerical values. The graphs showing the factors for computing the compressibilities of gases up to pressures of 200 atmospheres contain nearly all of the published data covering this range of temperature and pressure, and the curves are drawn accord-

ing to what appear to be the most probable values. The graphs indicating the volume *of gas delivered from a cylinder containing* the gas at high pressure have been computed for cylinders having a volume of 1.528 cubic feet, which is the volume of the so-called "200-foot" cylinder. For a cylinder of any other capacity the volume delivered would be proportional to the volume of the cylinder. In other words, the figure obtained from the graph should be multiplied by $\frac{V}{1.528}$, where V is the volume (in cubic feet) of the cylinder in question.

LITERARY INTELLIGENCE.

Sir Jagadis Chunder Bose, whose recent botanical discoveries have evoked worldwide interest, has written an account of them which Messrs. Longmans, Green and Co., Ltd., will shortly publish. The complete account will be in two volumes, but the first, which is nearly ready, will deal with the Nervous Reflex in Plants.

FORTHCOMING EVENTS.

ROYAL SOCIETY.

Thursday, February 11, at 4.30 p.m.

ROYAL SOCIETY OF ARTS.

Wednesday, February 10, at 8 p.m. Professor J. C. Drummond, D.Sc., F.I.C., "Modern Views of Vitamine." Charles James Martin, C.M.G., F.R.S., etc., is to preside.

ROYAL INSTITUTION OF GREAT BRITAIN.

Saturday, February 6, at 3 p.m. Sir Walter Davies, "The Third and the Perfect Fourth."

Tuesday, February 9, at 5.15 p.m. Dr. Eric K. Rideal, "Surface Action."

Thursday, February 11, at 5.15 p.m. Dr. J. L. Myres, "Who were the Greeks"

Friday, February 12, at 9 p.b. Robert Robinson, D.Sc., F.R.S., Professor of Organic Chemistry in the University of Manchester.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Thursday, February 11. Annual Dinner at the Hotel Cecil, at 7.30 p.m.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

The following paper will be read on February 9, 1926, at 5.30 p.m.: "The Sulphur Compounds of Kimmeridge Shale Oil," by Frederick Challenger, D.Sc., Ph.D., F.I.C.; John Haslam, M.Sc., A.I.C.; Randle James Bramhall, B.Sc.; and James Walkden, M.Sc.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

917.—Buchner, M. — Production of soluble salts of organic compounds. January 12th.

1,114.—Soc. of Chemical Industry in Basle.—Manufacture of a thioindoxyl derivative. January 14th.

Specification Published.

245,352.—Soc. of Chemical Industry in Basle.—Manufacture of permanent emulsions.

237,615.—Meyerhofer, A. F.—Process of producing complex salts of hydrofluoric acids.

Abstract Published.

243,556.—Resins.—Schaal, E., 77, Ludwigsburgerstrasse, Feurerbach, near Stuttgart, Wurtemberg, Germany.

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MERTON HOUSE, SALISBURY SQUARE, LONDON, E.C.4.

THE CHEMICAL NEWS,
VOL. CXXXII. No. 3435.
MERTON HOUSE, SALISBURY SQUARE,
LONDON, E.C.4.
TELEPHONES :
Administrative : Central 6521.
Printing Works : Hop 2404.

DVI-MANGANESE AND EKA-CAESIUM

By F. H. LORING.

In this Journal, towards the end of last year, Dr. Druce and the writer contributed a series of articles which related to the existence of elements of atomic numbers 75, 85, 87, and 93.

The first proper evidence of the existence of element 75 in manganese compounds appeared to be revealed on the X-ray Film No. 3. Films Nos. 1 and 2 were inconclusive, as the range of exposure was limited to a narrow region on the film and the X-ray tube was not working at its best then. Reference to the above-mentioned articles and a letter in *Nature* by the present writer (*January 30, 1926) will make this matter* clear.

Film No. 3 showed a line agreeing closely with the $L\alpha_1$ theoretical line of element 87 (eka-caesium). The $L\beta_1$ line of this element came in the Br-Ag region, and it was difficult to see it clearly, but by using the spectrum comparator, this line was *roughly foreshadowed* (see *Chem. News*, December 11, 1925), at least, so it would seem.

This film has been intensified, with the result that some incomplete and very very faint lines now appear on the film, but they would hardly be regarded as proper lines. Those proper lines seen before were, however, made strong enough to measure rather more accurately; and consequently Messrs. Adam Hilger, Ltd., were asked to remeasure and recalculate the lines with the following result. The wave-lengths are in Angström units, as before.

The estimated intensities of the five strongest lines are relatively about as follows :—

$L\alpha_1$ 125, $L\beta_1$ 100, $L\beta_2$ 49, $L\gamma_1$ 88, $L\beta_3$ 15.

The 75 $L\beta_2$ line was looked for on the intensified film, but not found thereon. It is rather surprising that this line did not show as the film was a good clear one, free from defects, and the lines above indicated were of moderate strength and could be easily seen. This may throw some doubt on the existence of element 75 in the sample examined by X-rays, but the mercury difficulty is removed.

The supposed $87L\alpha_1$ *line is now nearer* to its calculated value and further removed from the $L\beta_1$ line of mercury of wavelength 1.0458, *which was not, therefore, on the film.*

Our technique was good, for two consecu-

FILM No. 3.

Lines as first seen and meas. with the error entered against them.	Corresponding lines as seen and measured after intensifying the film.	Theoretical wave-lengths for those lines seemingly identifiable with elements 75 and 87.
Cu Kα	Cu Kα	
λ = 1.434 0.005	λ = 1434	$75L\alpha_1$ 1.4298
Cu Kβ	Cu Kβ	
λ = 1.232 0.005	λ = 1.234	$75L\beta_1$ 1.2358
λ = 1.032 0.005	λ = 1.029	$87L\alpha_1$ 1.0276
Br Abs.	Br Abs. darker.	Calc. values not accurate in the fourth decimal place.
Ag Abs.	Ag Abs. darker	
No other lines on the film.	No other proper lines on the film.	

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tive controls were run at the same time (see *Nature*, cited above). Moreover, in another experiment, Kahlbaum's normal manganese phosphate was rubbed on the face of the copper anticathode, and a film exposed 10 hours to the resulting radiation. The current and voltage conditions were as described in this Journal (October 30, 1925). Except for the strong copper lines, only two very faint (hardly visible) lines of wave-lengths 1.483 and 1.283 (the experimental error being 0.005 as before) were seen. The range of exposure was the same as Film No. 3.

Intensifying Film No. 3 has not helped us with regard to the suspected $L\beta_1$ line falling in the darkened region on the film. On examination with diffuse radiation, *i.e.*, with the film held against an anteriorly illuminated smooth opal shade and examined with a lens large enough to admit the image to both eyes without strain, and giving slight magnification, the line in question seemed to be partly visible.

In conclusion, it will be seen (1) that the presence of a mercury line 1.0458 is completely ruled out; (2) that the $L\alpha_1$ line of eka-caesium is made more probable; (3) that the absence of the $L\beta_2$ line of 75 is an element of discord in the scheme as developed from the first sample and the earlier films; (4) that no further evidence of the existence of the $L\beta_1$ line of eka-caesium is obtained, though the findings previously published in this respect are in no way discredited; (5) that sufficient control experiments were made to show good technique.

THE ELECTROLYSIS OF LEAD CHLORIDE.

By Robert Saxon, B.Sc., F.C.S.

Using a carbon anode and an iron cathode throughout these experiments, there is much to record in the way of failure to get a good deposit of the metal from lead chloride, which is very sparingly soluble in cold water, but much more so in hot. The plain chloride solution conducts very badly, and there is no deposit of the metal except on the introduction of impurity, and then only traces after hours of running. As the resistance heats the liquid, more of the chloride is ionized and the oxide is deposited, but in very meagre quantities.

The addition of sodium chloride improves the yield of oxide, but very little of the metal is thrown down. On the introduction of an *idle electrode* (one between the others unconnected) the yield is greatly improved. The acceleration brought about by this is by no means so great as with copper, nickel or cobalt salts.

Caustic potash or soda retards the reaction, tending to form the hydrate and oxide of lead as soon as the chloride dissolves. Ammonium hydrate and ammonium chloride have a like effect. Ammonium nitrate in which lead chloride is somewhat soluble does not assist appreciably, as the current discharges the ammonia, and the disintegrating nitric acid thus cast loose, produces oxide instead of nitrate of lead. At no stage is it possible to get lead nitrate to crystallise out on evaporation, though the crop of oxide increases as electrolysis proceeds.

As there is a superabundance of water, it is oxygen and not chlorine liberated at the anode, and the carbon disintegrates rapidly. This carbon heated along with the lead oxide rapidly reduces it, as both are in a finely divided state, and this fact suggests the addition of some finely divided reducing agent in the electrolyte. As a soluble one, sugar was tried.

A saturated solution of sugar containing more lead chloride than boiling water will dissolve, acts well. A copious rain of lead appears as soon almost as the current is switched on, and the electrolyte offers little resistance to the flow. What is more important, the *carbon anode suffers no appreciable disintegration*. The deposit of lead is fine enough to float. The whole is filtered and the deposit washed with boiling water until the filtrate shows no cloudiness with ammonium sulphide. The lead may now be partly dissolved in nitric acid, and tested for lead. The rest may be melted in a crucible, when it turns yellow though refusing to flow, being too fluffy and ready to oxidise. This proves to be lead oxide on solution in nitric or acetic acids. This spongy lead dissolves in nitric acd with the production of brown fumes, always a rough and ready indication of a metal as against an oxide.

There is produced during electrolysis hydrochloric acid, and an indicator such as methyl orange is reddened immediately action begins. By dilution and comparator tests with known strengths, the amount of acid may be computed. Thus may be set up a standard list of speeds of electrolysis

for various electrolytes judged by the rate at which an acid common to all concerned is delivered. Saturated with sugar and lead chloride, water will deliver hydrochloric acid at about one-fifth the rate that a saturated solution of copper sulphate delivers sulphuric acid. It is impossible, however, to regulate conditions so that two experiments shall proceed even approximately at the same temperature, etc., therefore comparisons must be only very rough ones.

An idle electrode aids the reaction a little, but at the same time displaces lead from the chloride. This is seen if a piece of zinc be placed in the vessel destined to receive the filtrate consisting of lead chloride dissolved in hot water. There results an abundant crop of lead on the zinc, not, however, nearly so "heavy" as that obtained on the cathode during electrolysis. Here we have the advantage of boiling water, whereas in electrolysis, the temperature has not risen above 49 degrees C.

General Notes.

THE CHEMICAL SOCIETY AND ITS LATE PRESIDENT.

The Council received with regret the resignation, through ill-health, of the President, Dr. Arthur W. Crossley, at its *meeting on January 31. The following* resolution was passed :—

"The Council, having received with great regret Dr. Crossley's wish to resign the Presidency at the close of his first year of office on the ground of ill-health, desires to express its sincere thanks for the services he has rendered as President, and its best hope that his recovery may be speedy and complete."

UNITED STATES INTERESTS AFTER PACIFIC GREAT EASTERN RAILWAY.

We are advised by the High Commissioner for Canada that Portland and SanFrancisco capitalists are reported to be preparing to make an offer to the British Columbia Government for the purchase of the Pacific Great Eastern now that the railroad has had 25,000 square miles of lands, including very rich natural resources, added to its assets. It is likely that a definite proposal will be made to the Government early in this year.

The stipulation in the recent legislation that the lands will be free from taxation for a period of twenty years is said to have added greatly to the attractiveness of the proposition.

Included in the areas turned over by the Crown to the railroad are said to be some of the most valuable assets of the province. In the block to the east of the Fraser, and south of Quesnel Lake are coal and other minerals, the value of which cannot be estimated, whilst the surface rights include good farm lands. The other block in the Cariboo district is reported to include some of the finest stands of pulpwood in the world. The Chilcotin block, it is stated by those familiar with the country, is of rare worth as stock grazing and ranching areas. The Peace River block, which is immediately to the west and south of the federal reserve, not only contains fine farming lands, but it is said has every indication of being the repository of extremely valuable oil and coal measures.

CANADIAN PROGRESS.

During 1925 metals produced valued 125,410,000 dollars, as compared with 102,466,528 dollars in 1924.

Fuels and other non-metals, last year valued 70,650,000 dollars, as compared with 71,796,009 in 1924.

Structural metals and clay products in 1925 were valued at 33,000,000 dollars, as compared with 33,380,869 dollars in 1924.

The grand total last year was 228,440,000 dollars, and in 1924 209,383,406 dollars.

CANADA'S NEW PRODUCTION RECORDS.

During 1925, Canada made some very great advances in production over the previous year, as is evidenced by figures that have already been given out. The copper output amounted to 112,526,000 pounds in 1925, against 104,457,447 in 1924; zinc, in 1925, 111,010,000 pounds and in 1924, 98,909,077 pounds; nickel, 73,150,000 pounds in 1925, and 67,536,350 pounds in 1924; lead, in 1925, 253,964,000 pounds, while in 1924 it was 175,484,099; asbestos, 260,000 tons in 1925, compared with 225,744 tons in 1924. Ontario's output of gold in 1925 was $30,000,000, against

$25,675,000 in 1924, and of silver, 10,555,000 ounces, against 9,922,335 ounces in 1924. The total value of Canada's mineral production in 1925 is estimated at $228,440,000, compared with $209,583,406 in 1924. Canadian bank assets and deposits shewed substantial increases.

ALL-ROUND PROGRESS.

Failures in 1925 were 2,035, with liabilities of $34,548,145, against 2,287 failures in 1924 with liabilities of $42,279,820. New life insurance written in Canada last year amounted to $800,000,000, against $732,594,924 in 1924. Canada's total exports for the twelve monthe ending November last were $1,215,893,680, compared with $1,058,544,153 for the same period last year, while her imports for the 1925 period were $874,295,547 against $812,905,156 a year ago.

CANADA'S ACHIEVEMENTS BY COMPARISON.

Sir Henry Thornton, President of the Canadian National Railways, says:—

"From 1901 to 1911, Canada's increase in population of 34.1 per cent. was equal to the best decade in the history of the United States. In the period 1911 to 1921, when Canada's progress was halted by the war, the increase in population in Canada was 21.95 per cent., as against an increase of 14.9 per cent. in the United States. Equally encouraging are the following figures: In 1870, with great petroleum fields, gold, copper, iron ore mines and the greatest coal fields just where they were most needed, the 38,000,000 people of the United States were producing approximately the same value of mineral as the 9,000,000 of Canadians are to-day. In 1880, 50,000,000 people in the United States were manufacturing an equivalent of what Canada, with 9,000,000 people does to-day. Furthermore, Canada's 9,000,000 people have developed a larger foreign trade to-day than the 76,000,000 people of the United States had developed in 1899. Not only is this the fact, but the *per capita* value of Canada's exports from August, 1924, to August, 1925, as compared with those of the United States over the same period shows—Canada, $125; the United States, $37. The average unemployment in the United States is 1,800,000 persons. Never in the records of this country can we find a proportionate number out of employment. And Canada's best years are ahead. In so far as the immediate past year is concerned, even bank presidents, the most cautious of individuals, have discovered very little to find fault with."

"Sir Vincent Meredith, chairman of the Bank of Montreal, recently informed the bank's stockholders that wheat would probably bring in $500,000,000 new money from this year's crop. On the basis of a price of $1.50 per bushel, the 165,000,000 bushels remaining to be sold, if added to the receipts from the 142,000,000 bushels previously exported, would expand Sir Vincent's total by $13,000,000 or so and raise the Government estimate by more than $50,000,000. A big market awaits Canadian wheat.

"Canada is sitting in a preferred position with a large exportable surplus still to be sold at prices which promise to be good. The wheat crop was large and the average of other crops was not much different from that of 1924; some went back, while others increased. Increased wealth should bring in its wake increased purchases of manufactured goods. It looks like a good business year north of the border in 1926."

INTERNATIONAL COMBUSTION, LTD.

Mr. W. J. Cotterell, M.I.Mech.E., M.A.S.M.E., will be sailing for South Africa on 29th inst., by the R.M.S. "Walmer Castle," in connection with the important contract recently awarded to International Combustion, Limited, by the South African Electricity Commissioners, for the power station at Congella, Durban.

LONDON'S NEW SUPER-POWER STATION.

North Metropolitan Electric Power Supply Co., Brimsdown.

This announcement will confirm what has been a subject of general comment for the past three or four months. in that the proposal of the North Metropolitan Electric Supply, Company to establish a power station upon an existing site at Brimsdown, near Enfield, North London, has now taken definite shape, and the contracts for the first section of the station of 40,000 k.w. capacity, have been duly placed; with the

object of completing and operating in a period of twelve months.

As main contractors, the Foundation Co., Ltd., have been selected with the International Combustion Limited principal sub-contractor.

International Combustion Limited, have been awarded the whole of the contract covering steam generation and transmission, and their well-known "Lopulco" system of powdered fuel firing is to be installed.

Five boilers, each of 10,100 square feet heating surface, have been ordered, and these are to be manufactured by Messrs. Babcock and Wilcox, to the order of International Combustion Limited, and will conform to their requirements in design.

Each of these boilers will be equipped with the "Lopulco" patent water screens and "Murray Usco" fin furnaces, which will increase the total heating surface of each boiler to 11,000 square feet.

The "Lopulco" equipment will include the latest design of pulverising mills, each of fifteen tons per hour capacity, and which, with the feeders, burners, exhausters, bunkers, separators, "Lopulco" water screens, "Murray Usco" fin furnaces and draught equipment, will be manufactured by International Combustion Limited, at their own works situated at Barrow and Derby, and will provide continuous employment to a large number of British workers.

This station, when complete, will be the largest in the London area operating entirely with pulverised fuel, and the results will be awaited with much interest.

A "LIVING" CELL.

A notable achievement in science is attributed by the *Scientific American* to Dr. D. MacDougall, director of the Carnegie Laboratories for Plant Physiology at Tucson, Arizona.

Dr. MacDougall's cell is composed of the same substances as those occurring in living matter. It grows and absorbs sodium and potassium selectively in a manner similar to that of plants. Dr. MacDougall's assistant, Dr. B. L. Clarke, explained that the artificial cell is not like the living cell, and needed "winding up," or the substitution of new substances for the spent ones. It would take up food material and water for a short period with an accompanying increase in size, but the process later ceased, unless new substances were provided. The period of absorption and growth is short.

The editor of the *Scientific American* remarks that "it would be an exaggeration to say that Dr. MacDougall has created a living cell, but he has succeeded in producing a good substitute for purposes of study and experiment. His cell does possess some of the properties of the living plant cell. It may be that we shall never produce life artificially, but Dr. MacDougall's achievement brings us nearer to answering the question, "What is life?"

OPTICAL SOCIETY.

The report shews that nine ordinary meetings were held during the year, all the papers submitted being of merit. There are now 293 members of various grades, and the Committee is desirous of increasing the number so as to maintain and extend the usefulness of the Society. The finances are in a sound condition.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read in title at the meeting on January 21, 1926:—

Atmospheric Diffusion Shown on a Distance-Neighbour Graph. By L. F. RICHARDSON. Communicated by Sir Gilbert Walker, F.R.S.

The atmospheric diffusivity in Fick's equation has been found by various investigators to increase from 0.2 to 10^{11} cm.^{2} sec.$^{-1}$ as the size of the cluster of diffusing particles increases from 10^{-2} to 10^8 cm. The effect is due to eddies of many sizes acting together. There is apparently no way of modifying Fick's equation in order to describe this phenomenon. But a new mathematical method is here developed, in which, instead of thinking about concentration as a function of position, we think about q, the mean number of neighbours per length, as a function of l, their distance apart. Formal definition is given to this idea, and various properties of it are investigated. For simplicity only distributions on an unbounded straight line are considered. If the movement of concentration v is described by Fick's equation

$$\frac{\delta v}{\delta t} = K\frac{\delta^2 v}{\delta x^2},$$

then it is proved that

$$\frac{\delta q}{\delta t} = 2K\frac{\delta^2 q}{\delta l^2}.$$

If, however, the diffusion is "non-Fickian," as in the atmosphere, then the former of these equations cannot be generalised, but the latter can, taking the form

$$\frac{\delta q}{\delta t} = \frac{\delta}{\delta l} F(l)\frac{\delta q}{\delta l} .$$

A discussion of existing observations shows that a rough average value is F(l) = 0.6 $l^{4/3}$ cm.^{2} sec.$^{-1}$ for the atmosphere, when l lies between 1 metre and 10 km. The diffusion of a lamina is worked out *from these principles*. The *diagram* obtained in this way exhibits the size of a cluster, because it is proved that the standard deviation of the (l, q) area from *its centre* $l = 0$ *is* $\sqrt{2}$ *times the standard* deviation of the cluster from its centroid.

Two methods are prepared for the observation of F (l) by balloons or smoke.

Some Phenomena Occurring at the Surface of Bubbles in Water. By T. ALTY. Communicated by Sir Joseph Thomson, F.R.S.

1. The surface tensions of water in contact with various gases are compared by the drop-weight method. The weight of a bubble is independent of the gas used if the rate of flow is slow enough.

2. To examine a new water surface, the rate of flow is increased until several bubbles emerge per second. After making necessary corrections, it is found that the volume of the bubble depends on the gas used. It is greater for inert gases and smaller for chemically active gases.

3. When flowing from the same capillary, the gases form bubbles whose volumes can be arranged in decreasing order as follows: A, N_2, O_2, O_3, H_2, NO, CO_2.

4. These differences are related to the adsorbability of the gases.

The Line Absorption Spectra of the Alkali Metals. By A. L. M. SOWERBY AND S. BARRATT.. Communicated by Prof. T. R. Merton, F.R.S.

1. The alkali metals are all able to absorb the lines of the combination series 1*s-md*, contrary to the Selection Principle. The cæsium series of this type has been observed for the first time.

2. The absorption of this series by potassium is uninfluenced by the presence of *argon at two atmospheres pressure.*

3. It is estimated that 12,000 times as many atoms can absorb the first member of *the principal series* of *potassium and* rubidium as can absorb the line 1s-3*d*, the ratio being the same for the two metals.

4. The " atomic extinction coefficients " of the different alkali metals are approximately the same for corresponding lines.

The Mobility of Ions in Air. Parts I. and II. By A. M. TYNDALL AND G. C. GRINDLEY. Communicated by Dr. A. P. Chattock, F.R.S.

The improved method of measuring mobility depends on producing ions by flashes of α-rays subjected to a special alternating field, under conditions such that when the current arrives at an electron and it plotted with frequency of the field, a sharp-peak curve is got, the position of which given an accurate measurement of the mobility.

Negative ions are first studied. The method gives mobility of those fully formed. Effect of water vapour is to cause fall of mobility down to a value 1.6 in saturated air. The great majority of ions are of one kind under resolving power and frequency available.

Positive ions of two types were found—initial and final. Mobility of the initial is indistinguishable from negative and is similarly affected by water vapour, thus agreeing with Erikson's results. But water vapour was found to have a retarding influence on rate of transformation into final ions. In ordinary dry air much transformation occurs within 0.007 second of birth, but in wet air the ions nearly all remain in the initial stage at double this age.

Theoretical discussion is postponed.

A Band Spectrum of Tin Monochloride Exhibiting Isotope Effects. By W. JEVONS. Communicated by Prof. H. C. Plummer, F.R.S.

1. The spectrum of the uncondensed discharge through $SnCl_4$ vapour comprises a continuous spectrum between λ 4900 and λ 3950, and a hitherto unrecorded band spectrum consisting of two distinct sets of bands occupying the regions λ 3910 —

λ 3486 and λ3405 — λ 2830 respectively. Each set is attributed to a chloride of tin.

2. The bands in the more refrangible set constitute two systems α and β of the normal Deslandres type. The systems closely resemble one another (*a*) in the ranges of values of the initial and final vibrational quantum numbers, n', n''; n' in each system ranging from 0 to 4 or 5, and n'' from 0 to 8 or 9; (*b*) in the intensities of like-numbered bands, and in their intensity-distribution, which is of a fairly normal type; (*c*) in their progressions of first differences of wave-numbers, and ,therefore, in their vibrational energy coefficients; and (*d*) in consisting of bands which degrade towards the further ultra-violet; indicating that the moment of inertia of the molecule is greater in the final state than in the initial state, in the case of each system.

3. The separation of like-numbered bands in α and β increases appreciably with n'', while it is independent of n'. This indicates a common initial electronic state (with its associated vibrational states) and two distinct final electronic states, (each with its associated vibrational states) for the two systems. The two final (α andβ) electronic states of the molecule are not very different as regards vibrational energies and, therefore, inter-atomic forces.

4. If systems α and β be ascribed to $SnCl^{35}$, a few additional bands in the same region are attributable to $SnCl^{37}$. This Cl isotope effect affords considerable support for the above assignment of n', n'' in each system. There is also some indication of the Sn isotope effect.

5. The less refrangible set consists of several gronps, each containing a few close bands degraded towards the red. Too little is known of these bands to say whether they are emitted by SnCl or by a poly-atomic chloride.

Some Physical Properties of Steel and Their Determination. By J. H. Andrews, M. S. Fisher, and J. M. Robertson. Communicated by Prof. H. C. H. Carpenter, F.R.S.

Methods of measuring electrical resistance, electrode potential, and continuous change of resistance during tempering, are described. By these the effect of heat-treatment on the constitution of series of carbon, nickel, chromium, and nickel-chromium, steels has been investigated.

From the tempering results, it is deduced that there is a gradual change from martensite to granular pearlite, and that this change only proceeds to a certain stage at each temperature. Electrode potential measurements indicate that this gradual change is accompanied by a change in the amount of carbon in solution in the ferrite, as well as in the state of division of the constituents.

From the measurements of the change of resistance during tempering, it is concluded that martensite is not formed during tempering at constant temperature, but results from the decomposition of austenite during cooling from the tempering temperature. From the tempering resistance-curves, it is deduced that the rate of tempering of martensite is not affected by the addition of moderate amounts of special elements.

A method of resolving the tempering-resistance curves of partly austenitic steels into components, representing the tempering of martensite and of austenite respectively, has been devised; it is found that austenite tempers more slowly than martensite, and the rate of tempering of austenits is considerably reduced by addition of special elements.

ROYAL SOCIETY OF ARTS.
(*Cantor Lectures.*)

COAL ASH AND CLEAN COAL.
By R. Lessing, Ph.D., M.I.Chem.E.

Lecture I.—*Delivered November 23, 1925.* (*Abstract, Journal of Royal Society of Arts.*)

The Economic Significance of the Mineral Constituents of Coal.

To realise the bearing which the mineral constituents of coal have on the economics of the fuel requirements of Great Britain, it might be useful to give one striking example.

In the absence of reliable statistics it is safe to take the mean percentage of ash in coal put on the market to be 10%. If we assume the annual coal production in Great Britain to be 250,000,000 tons, we find that upon burning the coal or the coke made from it, 25,000,000 of incombustible material are obtained. The average length of haul of coal by railway companies (exclusive of private lines) is about 43 miles, and with a freight rate of slightly more than one penny per ton-mile, the average

railway receipt for the last period for which returns are available (March, 1925), works out at 3s. 8d. per ton. We are, therefore, spending approximately £4,500,000 per annum on material which is worse than useless, *since probably more than double this* amount is expended in the collection and disposal of the ashes from the place of consumption to their final resting place. The consequential losses from lowering the combustion and carbonising efficiencies can hardly be estimated with any degree of accuracy, but they again will be a multiple of the figure quoted. The country's non-productive expenditure on this score may, therefore, be safely put at the stupendous figure of from £10-20,000,000, a waste which surely should be a worthy subject of the closest scientific, technical and economic examination.

Influence of Inorganic Compounds on the Formation of Coal.

To comprehend the full significance of the mineral constituents and companions of coal, the manner and conditions of its formation should be constantly kept in mind. This problem, on account of the multitude and variety of factors governing the incidence and the properties of coal deposits seems almost incapable of a complete solution and a good deal of the geological, petrographical, botanical, physical and chemical evidence on its different phases remains inconclusive.

It cannot be my task to enter into a discussion of the many hypotheses advanced to explain all or any of these phases. It may suffice to recall that ordinary coal is a compact ,stratified mass of the remains of plants, which have undergone partial decay varying in character and arrested at different stages. With the exception of cannels, in the accretion of which the *micro-organisms of plankton and marine* fauna played a part, the practically exclusive vegetable origin of coal requires no further proof.

The principal differences between various kinds of coal are due (1) to the kind of vegetable raw material from which they were formed; (2) the conditions under which this material was accumulated; (3) the agencies by which it was decayed, and finally (4) the stage at which these biological, chemical and physical processes came to a standstill or—more strictly speaking, and recognising the never-ceasing activities of nature—the stage at which these changes have arrived in our geological era.

The plant material may have varied from tree trunks down to fragments of twigs, leaves, spores, pollen, algæ and micro-organisms of any kind that formed the forests, swamps and other vegetation of the *palæoic, or in the case of younger coals*, of later periods.

The accumulation of these vegetable masses has varied locally according to their deposition in sea water, brackish water, fresh water or on land.

The resultant products of decay, apart from the material from which they are derived, and its environment, are dependent on the kind of change it has undergone; this may have been bacterial, enzymatic or purely chemical, and subject to aerobic or anaerobic, oxidising or reducing conditions, and to climatic and other physical factors, such as heat and pressure.

These four groups of factors, involved in determining the formation, structure and constitution of coal ,are each and all influenced by the nature of the inorganic compounds with which the organic material is associated or in contact.

Inorganic Plant Constitutents.

In the first place must be mentioned the inorganic constitutents of the plant substance, although as will be seen later, this source is quantitively the least important. The consideration of that portion of coal " ash " contributed by the plant itself, involves a study of plant physiology, and particularly plant metabolism, a subject the vastness and complexity of which does not permit of giving it here more than the most casual attention. A more detailed examination of the relation of plant ash to the inorganic constituents of coal has recently been made by P. Haas (" Fuel in Science and Practice," 1925, IV., 424), from which the intricacies attaching to the study of the ash even of present-day plants become manifest. The difficulties of interpreting the experimental results obtained from the examination of fossil coal are enhanced by the fact that we are dealing with a vegetation concerning the composition of which we can only speculate from analogy with modern plants and a vegetation the conversion of which into coal must have also affected its inorganic compounds.

The number of " essential elements " (other than carbon, hydrogen, oxygen and nitrogen) invariably occurring in plant ashes, *viz.*, iron, calcium, magnesium, potassium, sulphur, and phosphorus, provide by their varying proportions and total

content a wide range of combinations which are added to by other elements, such as silicon, aluminium, manganese, sodium, chlorine and iodine, which are "non-essential," but may persistently occur in some plants.

Complications arise from the differences in the ash content and composition of different kinds of plants, and different parts of a given plant; thus the ash may vary from a fraction of 1 per cent. in the wood to 20 per cent. or more in the leaves, the living tissues being always higher in ash than the non-living.

Further differences are introduced by seasonal and even diurnal variations, by the nature of the soil on which the plant grows, its age, the effect of salts in the water in the case of aquatic and marine plants, of sunlight or shade and many other factors ,difficult enough to elucidate by experiment with modern plants, but almost too complex to unravel from the mixture of vegetation decayed and transformed into what we know as coal.

And yet, I am convinced that the inorganic constituents of individual plant entities will form a useful guide in work on the constitution of coal, once methods are worked out for correlating them with the results from the analysis of the organic portion and the findings of microscopic examination.

Inorganic Compounds in the Accumulation of Coal-forming Material.

The accretion of the vegetable mass is subject to the influence of the conditions of accumulation. Material carried by, or laid down in salt or brackish water, covers itself with a salt solution which, after subsequent processes of evaporation or drying, leaves films of these salts upon the surface of the plant fragments. Even if a subsequent leaching-out of soluble salts with fresh water should take place, some of these will be retained by adsorption. Since the plant fragments are largely composed of colloidal substances, the electrolytes introduced with sea water cause coagulation to take place, which again tends to lock up the dissolved salts of the reacting solutions.

These phenomena must be regarded as one of the sources of the sodium chloride content of many coals which in practice shows itself as a destructive constitutent, when, as in coke ovens or gas rétorts, it is voltilised and attacks, as a fluxing agent, the refractory materials of which they are built.

Sodium chloride is, of course, not the only soluble salt which may thus be incorporated into the mass of coal-forming material, but the minor constituents of sea water play their part according to the laws of physical chemistry. For instance, the magnesium content of the dolomitic concretions known as "coal balls," must be ascribed to the magnesium chloride from sea water.

The admixture of inorganic substances to the coal forming magma is by no means restricted to soluble salts. The water with which the plant material came into contact had in many cases mineral detritus, mostly in form of mud suspended in it. This mud became intermingled with the vegetable mass or settled on it. Where it was finely sub-divided or in form of colloidal solutions, it percolated the magma with comparative ease to be deposited by gravity or by coagulation where the chemical conditions permitted.

Whilst contact with saline solutions or mud suspensions thus caused the deposition of inorganic substances, percolating water in other cases has brought about a leaching-out of the soluble plant salts and the minerals contained in the deposit. An important and as yet unexplained phenomenon is the difference between the total ash content of modern plants and the inherent ash of a large portion of most bituminous coals.

As in the adsorption or retention of salts by the peat or coal magma, so in the removal therefrom of soluble salts, colloidal phenomena play an important part. This is particularly the case where, by the decay of the vegetable debris, soluble organic compounds of an acid character, such as ulmic acid, are formed; solutions containing these, on percolating through lower layers leach out bases which are reprecipitated on continuing their downward path. In this manner a redistribution of certain inorganic compounds, notably iron and alumina, takes place, somewhat on the lines of the formation of hardpan, known to the agriculturist and forester.

In many respects the problems involved resemble those dealt with by the soil chemist, who is concerned with the first member of the chain leading from vegetable debris through peat, lignite and brown coal to bituminous coal and finally anthracite.

In the various theories evolved on the mode of decay of the raw material of coal and its degradation into a compact highly carbonaceous fuel, the function of the inorganic accessories has not yet been made the subject of close investigation. Whether the processes of coal formation were biological or chemical, it must from analogies in fermentation practice and from experience with catalysts be expected that the mineral ingredients had a very decided influence on the course of decomposition of the organic matter. The theory of Fischer and Schrader which postulates the disappearance of cellulose by biological agencies and the formation of coal from the lignin residue, although not generally accepted in its entirety ,may serve as an example, and in regard to it the observation of Hoppe-Seyler becomes significant that in the fermentation of cellulose, the reduction of calcium sulphate, the formation of ferrous carbonate and sulphide, and other reactions with inorganic compounds are closely connected with the degradation of the organic matter.

The separation by Stopes, of four distinct ingredients from bituminous coal made it possible to enquire more closely into their mineral constituents. These coal components are : *fusian*, the equivalent of "mother-of-coal," or "mineral charcoal"; *durain*, the dull hard coal; *clarain*, the portion of bright coal still containing plant debris; and *vitrain*, the bright coal of conchoidal fracture, originally thought to be without structure but now known to have a definite though largely obliterated structure. By the work of Stopes, Tideswell and Wheeler, Lessing and a number of subsequent workers, the differences in the microstructure of coal components were proved to be associated with characteristic differences in their hemical composition and properties, and notably in their behavious on extraction with solvents, thermal decomposition, oxidation and hydrogenation.

In particular it was shown that the four groups of ingredients varied in the amount and composition of their ash in a remarkable manner.

The ash percentages obtained from the first coal examined, the Thick Seam of Hamstead, South Staffs., were as follows :

	Ash per cent.
Fusain	15.59
Durain	6.26
Clairain	1.22
Vitrain	1.11

The four ashes showed considerable differences in colour and mechanical structure. That from fusain was dark brownish-grey; that from durain pure pale grey or almost white without the slightest brown tint; that from clarain a reddish-brown biscuit, and that from vitrain a pale biscuit colour. On burning large lumps, lamination is produced along the bedding planes of the coal. Clarain ash invariably contrains intrusions of grey plates indicating the presence of durain or possibly fusain, whilst vitrain also contains occasionally grey laminæ and red ferruginuous fusain, whilst vitrain also contains occasin form of a dense powder, whilst clarain and vitrain yield a light and unmistakably fluffy ash; its gossamer-like structure represents the skeleton of materials consisting to the extent of nearly 99% of combustible matter. These characteristics have been confirmed in the examination of so many coals that they must be regarded as typical for the four components and that the mere appearance of the ashes may form a useful and definite guide for their identification, with the qualification that differentiation between clarain and vitrain is not always quite easy on account of their close similarity.

GEOLOGICAL SOCIETY OF LONDON.

At the meeting held on January 20, Dr. J. W. Evans, F.R.S., in the Chair.

The Stratigraphy and Structure of the Cambrian Slate-Belt of Nantlle (Carnarvonshire). By Thomas Owen Morris, B.Sc., and Prof. William George Fearnsides, M.A., F.G.S.

This paper describes the results obtained by mapping, on the 6-inch and 25-inch scales, the rocks and structures exposed over about 10 square miles of the slate-quarrying district of Llanllyfni, Tal-y-sarn, Nantlle, and Moel Tryfan, in Carnarvonshire.

Stratigraphy.

The Nantlle Slate-Belt is the south-western part of the outcrop of the Cambrian rocks of Northern Carnarvonshire, which rest with appreciable unconformity upon the late pre-Cambrian volcanic rocks running south-westwards from Llanberis.

A correlation of these rocks with equivalent rooks in Southern Carnarvonshire and Merioneth is suggested. It is argued that the Lower Cambrian sediments are land-waste from the pre-Cambrian rocks of

North-Western Carnarvonshire and Anglesey, whereas the later Middle and Upper Cambrian material was brought in from an unkonwn source away to the east and south. Ordovician sediments are faulted against the basal member of the Upper Cambrian. A buttress or Ordovician volcanic rocks flanks the Nantlle area on the south-east side; but, within the area mapped, there are only altered dolerite-dykes, later than most of the impressed structures, to represent (and that a very late stage in) the cycle or Ordovician-Devonian igneous activity.

STRUCTURE.

The Nantlle district was deeply involved in the making of the Devonian alpine range, the basal wreck of which is now Snowdonia, and all sedimentary material within the Slate-Belt was compelled to fold, and then to crush until, both in bulk and in detail, it began to shear and creep. The importance of progressive movement in the development of cleavage is emphasised. Cleavage in the Nantlle Slate-Belt is almost vertical. Many folds have associated with them vertical strike-faults or slides, which, by tearing the middle limbs, have increased the vertical displacement. Often stronger beds are rolled out or packed as lenticles along surfaces of slip which behave as thrust-planes. Strong rocks rise on the north-western face of each slide, bend over, and are cut off by the next slide towards the north-west. The total displacement across individual slides, measured stratigraphically, may amount to many hundreds of feet. More boundaries of slate " veins " and quarry properties are determined by slides than by bedding-planes. Between slides the slate-beds have characteristic anticlinal structures, the synclines being suppressed. Some slides are evident surfaces of discontinuity, but the movement along many slides was prior to the completion of growth of authigenic minerals, and, as along cleavage-planes, these surfaces of slip are sealed. The scale and frequency of the folding at Nantlle is comparable with that in the mining district of Wanlockhead. The slide-blocks are longer and narrower than the strike-fault strips between Caermarthen and St. Clears; but secondary thrusting is impersistent, and not as orderly as in the schuppen which affect the Cambrian rocks of the North-West Highlands.

With removal of load by denudation, joints and other tensional fractures have appeared. The direction of some of these is related to rock-texture, but bevels, etc., cross them at acute angles. The latest cross-faults are master-fractures, which traverse all other structures as also the pre- and post-Cambrian formations that flank the Slate-Belt. The direction of these is north or north-west, as the geometry of the half-dozen which cross the quarry-region suggests that block-movement was associated with northward shift on the eastern side of each. Most of the dolerite-dykes follow bevels, and two have been intruded along the latest cross-faults.

A petrographic description of the pre-Cambrian rhyolites and of a hornblende-andesite is given, with chemical analyses. Petrographic evidence also establishes the existence of secondary (authigenic) micaceous minerals with or without recrystallised quartz in all the rocks of the Slate-Belt, and especially in those slates which are of greatest economic value. New-formed bladed chlorite is abundant in the Cambrian grits, and some of it is passing into biotite. Authigenic tourmaline in minute long prisms is a frequent constituent of both coarse and fine felspathic sediments throughout the Nantlle Slate-Belt.

A discussion followed.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The Improvement of Power Factor. By EDGAR WALL DOREY, Associate Member.

The first part of the paper summarises the principal types of apparatus employed for the imrovement of power factor, and gives a description of the modern static condenser and also of types of power-factor-rectifying plant that have been developed during the past three years.

The second part of the paper outlines various forms of the power-factor tariff in force in Great Britain, and is divided into two main classes; first, those hased on kVA demand, and second, those incorporating a power-factor bonus and penalty on the total supply bill.

Systems of metering employed in conjunction with power-factor tariffs are briefly dealt with.

MODERN METHODS OF IMPROVING THE POWER FACTOR.

In a paper written by the late Dr. Gisbert Kapp and read before the Institution on the 16 November, 1922, various kinds of plant

in use at that time for the improvement of power factor were described.

Auto-synchronous and synchronous motors.—It is unnecesary to enlarge further on what has already been written in regard to the use of auto-synchronous and synchronous motors, as, since the date of Dr. Kapp's paper, there has been no appreciable alteration or addition to the types then described.

Rotary Condensers.—The rotary condenser still finds little favour in Great Britain, where its field of application is very limited. The rotary condenser has a comparatively high loss, usually not less than 5 per cent., and may be as much as 7 per cent.; and when this loss is capitalised, the rotary condenser, under the conditions ruling in Great Britain, where power is mainly generated from coal, compares very unfavourably with other forms of power-factor-improving apparatus such as static condensers. Whilst in the larger sizes, say 500 kVA and upwards, the rotary condenser is, when compared with, say, the static condenser, less expensive in first cost, it is much less economical and more costly when running costs are taken into consideration.

To take as an example, a 1,000 kVA condenser equipment, the difference in losses between static condensers and rotary condensers would be of the order of at least 4 per cent. With a 12-hour working day, 300 days per annum, this would be equivalent to 144,000 units lost, and at 1d. per unit sold this is approximately £600 per annum. If this difference be capitalised it will show the static condenser installation to be by far the more economical.

Ball and Roller Bearings for Induction Motors.

The adoption of power-factor tariffs by supply undertakings has compelled designers to produce an induction motor with a very high inherent power factor, and the introduction by many manufacturers of a.c. motors fitted with ball and roller bearings has assisted greatly to this end. The smaller the air-gap the higher is the power factor, and it is obvious that with ball and roller bearings, where the wear that is attendant upon the use of the jonrnal bearing has not to be contended with, it is possible to use a much smaller air-gap, which is a feature of modern design.

An improvement of 2 or 3 per cent. in the power factor represents quite an appreciable saving on the supply bill where a power-factor tariff is adopted, and it would appear that ball and roller bearings will play an important part in the design of a.c. induction motors in the future, and many of the leading British makers to-day adopt such bearings as standard.

Static Condensers.

The oil-immersed electrostatic condenser was briefly described in Dr. Kapp's paper, but it is now proposed to deal more fully with this type of apparatus used for power-factor improvement.

Condensers of this type are manufactured in Great Britain principally by Messrs. British Insulated and Helsby Cables, Ltd., of Helsby, and the Telegraph Condenser Co., Ltd., of London. The condensers consist primarily of so-called Mansbridge plates, these comprising a length of paper coated with tin under the Mansbridge process. In the construction of condensers the Mansbridge plates are separated by the requisite thicknesses of paper used as the dielectric, the number of thicknesses being dependent upon the voltage applied across the terminals of the condenser unit. Generally speaking, each unit of the condenser has a capacity of approximately 1 microfarad, hut this may be greater or less according to the special conditions obtaining on the circuit.

To take as an example a 100-kVA 600-volt 50-cycle three-phase condenser; this would have a capacity of 88μF and there would be approximately 295 separate units connected in parallel on each phase, the phases themselves being connected in delta.

The two principal makers of condensers referred to above assemble the units in frames, the frames being fixed into boiler-plate tanks and completely oil-filled. The modern oil-immersed static condenser, which is now the result of many years' experience in the construction and application of this type of plant, may be regarded as a very reliable and efficient apparatus for the improvement of power factor.

A good deal has been said about the risk of resonance due to the connection of static condensers, but it will be agreed that experience is the best guide, and it may be safely said that over many years no difficulty whatever has been experienced in the application of condensers due to resonance. It is not claimed that resonance may not occur under certain exceptional conditions, but under the ordinary industrial conditions prevailing not only in Great Britain, but

overseas, experience goes to show that resonance does not occur.

The static condenser, as built in Great Britain, is essentially a medium-pressure apparatus, the most economical voltage being about 600, but condensers have been, and are, built for direct connection to supplies up to 3,300 volts. It should be noted that only in exceptional cases is it cheaper to supply a high-tension condenser, and that the saving is not even then very material, usually not more than 10 to 15 per cent. of the overall cost of the equipment.

Undoubtedly, the right place to put the condenser is on the low-tension circuit, as by so doing the improvement will be effected as far as possible out on the distribution network, and it has been found in practice that the call for high-tension condensers is very small compared with that for low-tension ones.

A case has been reported from overseas of a British-made 100 kVA 3,300 volt outdoor condenser, which, for the purpose of test and experience generally, is connected direct across the high-tension overhead transmission line without any protection whatever, and is therefore subject to every kick and surge on the system. Nearly 12 months have now elapsed since the condenser was first connected and it continues to give every satisfaction. This should be sufficient evidence to show that the static condenser does not in reality possess the attributes of frailty so frequently ascribed to it.

A comparatively new development is the low-tension pole-type condenser connected direct across pole-type step-down transformers, this application being particularly useful in the case of rural distribution. A number of British-made condensers of this type have been working for some considerable time in New Zealand, and it is reported by the engineer of one Power Board that, from the point of view of improved regulation only, the installation was worth while. In this case, however, the annual saving effected is sufficient to repay about 70 per cent. of the cost of the equipment, and to this has to be added the increase in the useful output of the transformer, as the condenser being connected on the low-tension side of the step-down transformer unloads the transformer of wattless current, and for every 2 kVA of condenser capacity under industrial conditions, the load on the transformer will be reduced by approximately 1 kVA.

The efficiency of the static condenser is very high, about 99.7 per cent., so that the losses are almost negligible. A bank of direct-connected condensers having an output of 1,000 kVA would have a loss of only 3 kW. Where auto-transformers are used for stepping up the voltage from that of the supply to the most economical voltage for the condenser, the auto-transformer losses have to be added, but the overall losses of large complete equipments for the usual industrial voltages may be taken to be between 1 and 1.5 per cent. of the output in kilo-volt-amperes.

It is well known that the output of a condenser is directly proportional to the plate area, and inversely proportional to the thickness of the dielectric, which latter is mainly dependent upon the applied voltage across the plates.

NOTICES OF BOOKS.

The Laboratory Book of Mineral Oil Testing. By Jas. A. Hicks (late Chief Chemist to Sir Boverton Redwood). VIII + 128 pp. Price 5s. net. London : Charles Griffin and Co., Ltd.

This work, which has been revised by Arthur W. Cox, F.C.S., and which has an excellent introduction by the late Sir Boverton Redwood, D.Sc. (Adviser on petroleum to the Admiralty and the Home Office), is clear and concise, and of the practical kind. Considering the great part which mineral oil plays in the commercial life of the world, it will be welcome, and goes a long way towards placing the testing of the commodity on a satisfactory basis. The author has given a useful manual which must be welcome to all connected with the mineral oil laboratory, and will be read with interest by all connected with the great mineral oil industry.

Allen's Commercial Organic Analysis. (A Treatise on the Properties, Modes of Assaying, and Proximate Analytical Examination of the Various Organic Chemicals and Products employed in the Arts, Manufactures, Medicine, etc.) Edited by Samuel S. Sadtler,, S.B., Elbert C. Lathrop, Ph.D. and C. Ainsworth Mitchell, M.A., F.I.C. X + 648 pp. 30s. net. London : J. and A. Churchill.

With such competent editors and the help of several eminent contributors, one will very naturally expect a work of outstand-

ing merit, and these expectations are amply fulfilled. Essential oils are dealt with very fully by E. K. *Nelson*, G. A. *Rasell*, Ernest J. Perry, B.Sc., and others. Essential oils of all kinds are exhaustively dealt with, and so (though to a lesser degree, obviously) are resins, indiarubber, gutta-percha, etc. It is a standard work, which will be appreciated by all concerned with or interested in the matters dealt with, and analytical chemists generally.

OFFICIAL AND OTHER PUBLICATIONS.

Canada To-day. The Annual Reference Book about Canada.

This is a profusely illustrated book of some 212 pages on the industries, resources, and progress of Canada. It is issued by the Canada Newspaper Company, Ltd., London, price 2s. 6d., a price which could not possibly pay for its production.

Canada.—Descriptive Atlas.

This is a quarto book of some 80 pages, giving maps of the various provinces, etc., composing Canada ,also letterpress shewing the population of cities, towns and villages, resources, industries, etc. It is issued by the Ministry of Immigration and Colonisation at Ottawa, and very naturally dresses the window attractively.

The Canadian Patent Office Record.

The Phillipine Journal of Science. (Bureau of Science, Manilla.)

Scientific Papers of the Institute of Physical and Chemical Research, Hongo, Tokyo.

Japanese Journal of Chemistry. (National Research Council of Japan.)

Mineral Resources of Alaska. (Department of the Interior, U.S.A.)

The Copper Deposits of the Near Salmon, Idaho. (U.S.A. Department of the Interior.)

Ore Deposits of the Saddle Mountain and Banner Mining Districts, Arizona, U.S.A.

Geology and Water Resources of the Mud Lake Basin, Idaho.

Surface Water Supply of the U.S.A., Part VII. Lower Mississippi River Basin.

We have received a copy of the "Grassendale" Diet Chart, compiled by Dr. S. G. Millimott and Mr. F. Wokes. The Chart summarises a vast amount of research on the chemistry of foods and nutrition; knowledge which, if properly applied, could be of the highest importance to the nation. Special attention has been devoted to the mineral and vitamin constituents.

One aim of the Chart is to indicate to medical men some of the more important applications of chemical principles in the prevention of disease.

FORTHCOMING EVENTS.

SOCIETY OF GLASS TECHNOLOGY.

Applied Science Dept., The University, St. George's Square, Sheffield.
Wednesday, February 17, at 2.30 p.m.

ROYAL INSTITUTION.

21, Albemarle Street, London, W.1.

Tuesday, February 16, at 5.15 p.m.. Prof. J. Barcroft, "The Egg." (1).

Thursday, February 18, at 5.15 p.m. Dr. J. L. Myres, "Who were the Greeks?" (3).

Friday, February 19, at 9 p.m. Hon. J. W. Fortescue, "George III. in his Papers."

Saturday, February 20, at 3 p.m. Dr. G. Macdonald, "Roman Britain." (1).

THE PHYSICAL SOCIETY. OF LONDON.

(Imperial College of Science.)

Friday, February 12, at 5 p.m. Annual General Meeting. The following papers will be read :—

"On the Hyperbola Method for the Measurement of Surface Tension," by A. Ferguson, M.A., D.Sc., and I. Vogel, B.Sc.

"The Application of Radiography to the Study of Capillarity," by E. A. Owen, M.A., D.Sc., and A. F. Dufton, M.A., D.I.C.

A demonstration of "The Application of the Piezo-Electric Properties of a Rochelle Salt Crystal and the Tri-Electrode Valve to the Determination of Impact Stresses in Granular Material," will be given by J. J. Hartley, M.Eng.M.Sc., A.M.I.C.E., and R. H. Rinaldi.

ROYAL SOCIETY OF ARTS.

Wednesday, February 17, at 8 p.m. James Edward Taylor, M.I.E.E., Superintending Engineer, Post Office Telegraphs, etc., South Midland District, "The Propagation of Electric Waves." Admiral of the

Fleet Sir Henry Jackson, K.C.B., F.R.S., in the Chair.

G. W. C. Kaye, O.B.E., D.Sc., Superintendent, Physics Department, National Physical Laboratory, "The Production and Measurement of High Vacua." Three Lectures, February 15, 22, and March 1.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

779.—Hohn, F. — Production of a chloride. January 11th.

1,753.—Coley, H. E.—Manufacture of metallic nitrides and ammonia from nitrogen. January 21st.

1,829.—Cussone, Ltd., G.—Supports for scientific apparatus. January 22nd.

2,058.—Lederer, O.—Manufacture of alumina salts from alumina-silicate etc. January 23rd.

1,549.—May and Baker.—Manufacture of amino derivatives of arlarseno compounds. January 19th.

1,387.—S. I. P. Soc. Italiana Potasa.—Method of separating aluminium nitrate from potassium, etc. January 18th.

Abstract Published.

243,990.—Alkali carbonates and hydrates. —Meyerhofer, A. F., 10, Goethestrasse, Zurich, Switzerland.

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THE CHEMICAL NEWS,
VOL. CXXXII. No. 3436.
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THE CHEMISTRY OF THE POLYCYCLIC STRUCTURES IN RELATION TO THEIR HOMOCYCLIC UNSATURATED ISOMERIDES. PART II.—INTRA-ANNULAR TAUTOMERISM.

By R. F. HUNTER, M.Sc., D.I.C., A.R.C.S.

As is proved by many well-known examples, the chemistry of condensed, and sometimes of supposedly simple alicyclic ring compounds, is frequently complicated by extraordinary transformations and interrelationships which it would be impossible to predict from an examination of the structural formulæ of the compounds concerned. As instances might well be quoted the changes connecting the three series of compounds derived from camphene, pinene and bornylene, or the conversion of alpha campholytic and alpha campholenic acids into their isomerides, isolauronolic and beta campholenic acids.

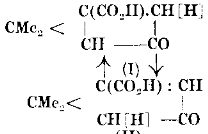
Of the methods which have been employed for the determination of the structures of alicyclic compounds, not only in terpene and camphor chemistry, but also in connection with the alkaloids, and generally wherever complex ring structures are encountered, no method has probably been used so extensively, nor been relied on as implicitly as the regulated oxidation by means of cold alkaline permanganate. But nevertheless, attention has been drawn in a previous article (*Chem. News*, 1924, CXXVIII., 209) to a case where the permanganate oxidation of a cyclic structure points to an incorrect conclusion. In this it will be recalled, the work of Ingold and Farmer on dimethyldicyclopentanone-dicarboxylic acid, was discussed, which, by synthesis from a cyclopropane derivative and by ferricyanide oxidation to caronic acid, and by the general study of its reactions, was shown to posesss the bridged structure, whilst on oxidation with cold alkaline permanganate behaved as though it had the *cyclic structure*, and passed rapidly and quantitatively into dihydroxy ββ dimethylglutaric acid and oxalic acid (*loc. cit.*) If the compound had been a natural product, or been obtained in any way other than by rational synthesis, the ring structure would certainly been accepted as representing the real constitution of the substance, and no search would have been made for an unusual oxidising agent such as ferricyanide, which oxidises the substance to caronic acid, and further, it is improbable that any of the facts respecting its chemistry would have aroused suspicion as to the ill-founded nature of the assigned structure based on alkaline permangante oxidation.

It appeared essential, therefore, to find whether this is an isolated substance, or if not, under what conditions the existence of such examples of chemical perjury might be suspected. And further, it seemed probable that a study of the matter might also do something to dispersing the mystery enveloping the mechanism of any peculiar alicyclic transformations to which reference has been made in this paper.

The view to which Thorpe, Ingold and Farmer (*Jour. Chem. Soc.*, 1922, CXXI., 128), were led by a close study of a number of compounds of the dicyclopentane series can be stated best in the words used in their original paper on the subject as follows : "In cyclic compounds there exists either potentially or actually, a type of tautomerism, analogous in some respects to three carbon tautomerism of the glutaconic acids, but, in addition, involving valency exchange across the ring. It will be our object in the present and subsequent parts of this series of papers to show how the occurrence of this phenomenon, which in future we may refer to as intra annular tautomerism, lies at the basis of, not only the remarkable changes of structure previously mentioned, but also those mutually contradictory decompositions in the bridged ring series which are best interpreted by ascribing to each compound a dual set of properties. The phenomenon of intra annular tautomerism reaches its culminating point in benzene and its derivatives."

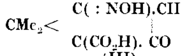
At the outset of the investigation of Ingold, Farmer and Thorpe, it appeared an excellent illustration of a substance capable of exhibiting mutually irreconcilable decompositions was ready to hand in the dimethyl dicyclopentanonecarboxylic acid

(II), the constitution of which rests on its synthesis from a cyclopropane derivative, its oxidation to caronic acid, and its intimate relationship with dimethyldcyclipentanonedcarboxylic acid (*loc. cit.*) from which it may be obtained in quantitative yield by heating to its melting point. Perkin and Thorpe had shown that the acid (I.) on treatment with alkaline permanganate, passes into αα dihydroxy ββ dimethyl glutaric acid, and it is true that both the dimethylcyclipentanonedicarboxylic acid and the dimethlylicyclopentanonecarboxylic acid can be converted nearly quantitatively by cold alkaline permanganate into the same dihydroxydimethylglutaric acid with approximately equal ease, aud by the accepted rules of evidence, therefore, the acid (1) should have the unsaturated constitution (2). It may be said at this point that the experimeuts of Thorpe, Ingold and Farmer (*Jour. Chem. Soc.* 1922, CXXI., 128) prove that the acid (II) is the tautomeric modification of the acid (1) which reacts as though it were the unsaturated isomeride in the presence of a suitable reagent for unsaturated compounds and the state of affairs is represented hy


(II)

However, it should be noted that an alternative explanation is possible. One might suppose that, unlikely though it appears, that under the influence of cold alkaline permanganate, the elements of water are added to the molecule by the fission of the bridge, and the complete disruption causes the formation of the dihydroxydimethylglutaric acid. Such a scheme, the essential feature of which is the intermediate production of a hydroxy acid, might be adopted to explain not only the action of permanganate of potash on the compound, but also a number of reactions and decompositions which were observed by Farmer, Ingold and Thorpe, and to appreciate the inadequacy of the interpretation, it is necessary to examine the evidence collected by these investigators in some detail.

The original acid (I or II) on treatment with nitrosyl chloride, yields a pale yellow oximino derivative which, on hydrolysis in the presence of formaldehyde and using hydrochloric acid, gives a diketonic acid which might have the constitution (IV) or (V), according to whether the original acid reacts in the form (I) or the form (II). It was conclusively proved that the oximino compound has the constitution (III) and that the diketonic acid has the structure (V).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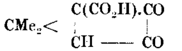
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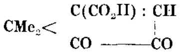

(V)

In the first place it was found that the diketone was obtained in two forms, a more stable bluish-red form and a less stable orange form. These appeared to be interconvertible in solution, but their stabilities at the ordinary temperature were sufficiently similar to enable them to be crystallised side by side, on the other hand it was found that the orange form immediately passed into the red form on melting. Whether these two modifications are merely physical isomerides or whether they bear to one another some such relationship as is suggested by the diketone and peroxide formulæ of the orthoketones is doubtful, but that the two modifications are not position isomerides there can be no question for in their chemical properties they are identical and with cold dilute alkaline hydrogen peroxide both pass easily and quantitatively into dimethlyaconitic acid, a reaction which exclusively shows the structure (V) to be the correct one. Dimethylaconitic acid was characterised by oxidation by means of cold alkaline permanganate to dimethlymalonic acid and oxalic acid and by the formation on treatment with water at 180° of dimethylitaconic acid which was prepared and characterised by Ssemenoff (*J. Russ. Phys. Chem. Soc.*, 1898, XXIII., 430). This reaction clearly involves the movement of a double bond so soon as the elimination of

a carboxyl group renders this possible. It is noteworthy that the diketonic acid in agreement with its unsaturated formula distils without eliminating its carboxyl group as carbon dioxide, this would be highly unlikely were the substance a beta ketonic acid of the structure (IV). It will be noted that the diketonic acid (V) is quite incapable of change into any tautomeric modification, having a bridged cyclopentane nucleus. The diketonic acid is, in fact, a non-tautomeric derivative formed by the replacement of the potentially mobile hydrogen atom in the unsaturated form of the tautomeric parent substance.

If further evidence is required for the real existence of the unsaturated modification (2) of the original acid, it is provided by the study of the ferricyanide oxidation of the substance. Farmer, Ingold and Thorpe were not able to identify all the oxidation products formed from the substance by the action of ferricyanide owing to the difficulty involved in the separation of these in a pure state, but, nevertheless, they succeeded in isolating, as well as a small amount of caronic acid derived from the oxidation of the bridged modification of the substance, a moderate quantity of dimethylaconitic acid, evidently derived from the unsaturated modification of the acid. For it is clear that if the mechanism to which we have made reference as an alternative explanation of the permanganate oxidation of the compound, that is, the intermediate formation of a hydroxy acid occurred, then the fission of the ring would give rise to dimethyl citric acid which would certainly not pass into dimethlyaconitic acd under the conditions of the experiment employed by Thorpe, Ingold and Farmer. It is obvious then, that the formation of dimethlyaconitic acid must occur by the fission of the unsaturated modification of the original acid, whilst the simultaneous production of caronic acid along with the dimethylaconitic acid which cannot be looked upon as formed from anything but the bridged modification of the acid, affords a remarkable example of the impossibility of interpreting the reactions of these compounds on the basis of a single structural formula to each.

There can be little doubt then, that certain bridged acids or the dicyclopentane series are in some circumstances capable of reacting as though they were unsaturated isomerides, and the whole of the chemistry of these compounds is built up of self-contradictory evidence of the type which ever since Baeyer's classical study of the example afforded by isatin, has been of basic importance in the development of the conception of tautomerism.

In the instances of Thorpe, Farmer and Ingold, the tautomerism has an intra-annular character, and it is of the utmost importance, therefore, to examine carefully the conditions which underlie the intra-annular interchanges. It is clear that the transformation of the bridged acid (1) into the unsaturated form (2) must involve the passage of a hydrogen atom across the cyclobutane ring from the position (2) to the position (4). The most natural assumption that can be made as to the mechanism of this change would seem to be that the mobile hydrogen atom passes by way of the ketonic oxygen atom which becomes, therefore, a kind of a stepping stone. The actual intra-annular change, therefore, takes place between the two enolic forms which are obviously valency isomerides.

The adoption of this explanation not only greatly simplifies the character of the intra-annular interchanges which have to be assumed, but also offers a reasonable explanation of the fact that in the case of dimethyldicyclopentanonedicarboxylic acid, which we have discussed in the first part of this series of articles, the bridged form appears to be relatively more permanent than in the case of the monobasic acid (I). That this is so is shown by the fact that a smaller yield of caronic acid is obtained from the monocarboxylic acid and again by the fact that, as prelininary experiments indicate, the dicarboxylic acid does not yield appreciable quantities of an oximino derivative when treated with nitrosyl chloride under conditions in which the oximino compound of the monobasic acid is readily obtained. It is clear that the attachment of a carboxyl group at the position (II) would have the effect of stabilising the bridged enolic phase since the componnd is now a substituted acetoacetic acid, and thus reducing the permanence of the unsaturated enolic phase would favour the reactions of the bridged modification. At this point it is worth while to consider the behaviour of the acids on sodium amalgam reduction. It is clear that either the bridge acid (I) or the unsaturated form of it (II) would yield the same dihydro derivative, the production of which ,therefore, is no

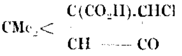
indication of the manner in which it is formed. In an investigation on the stability of spiro compounds by Thorpe and Ingold (*Jour. Chem. Soc.* 1919, CXV., 320), a quantitative study of the velocity of reduction of the monocarboxylated acid (I) or (II) was recorded, and the velocity found to be of the order of magnitude to be expected from considerations arising directly out of the strained valency hypothesis (*Chem. News*, 1924, CXXVIII., 389), which forms the basis of their paper on the subject and founded on the assumption that it is the bridged form (I) which undergoes reduction. Since the same would not be true were the unsaturated modification responsible for the production of the dihydro derivative, this result can be taken to indicate the main process occurring during the reduction is the fission of the bridge bond in (I). It follows that dimethlydicyclopentanonedicarboxylic acid should undergo reduction considerably more readily on account of its more permanent bridge phase, and this is actually found to be the case.

The analogy has been drawn (*Jour. Chem. Soc.*, 1922, CXXI., 134) between the acids of the dicyclopentane series and those remarkably stable five-membered rings of which thiophen and furan are types. In view of this analogy and indeed, the whole character of these acids as products derived from an intra-annular tautomeric system, similar in many respects to the benzene nucleus it appeared remarkable that Toivonen (*Annalen*, 1919, CCCCXIX., 212), should have obtained from the monocarboxylic acid (I) and bromine a-dibromo addition product, the formation of which was regarded as a proof that the acid had the simple cyclopentene structure. Unfortunately, however, an estimation of bromine content only is insufficient to distinguish between addition and substitution, and Tiovonen did not make a complete analysis of the bromo-compound. Actually the product is formed by substitution and not by addition, and its empirical formulæ contains two atoms of hydrogen less than the number assigned. Toivonen did not record his yield, but said that he used somewhat more than two atoms of bromine for one molecule of monocarboxylated acid, and that hydrogen bromide was evolved towards the end of the reaction. Thorpe, Ingold and Farmer re-examined this piece of work and found that the conditions specified by Toivonen give an 80% yield of the dibromo acid, but that it is necessary to use four and not two atoms of bromine; and when two atoms of bromine are used the product consists nearly entirely of a monobromo derivative which Toivonen did not isolate. Further, although in all cases hydrogen bromide is evolved only after the reaction has gone a fair length and the solvent employed has become saturated with the gas, its generation takes place from the commencement. It seems, therefore, that there can be little doubt that the reaction is one of substitution and not of addition.

These points having been settled, it appeared that the whole matter was sufficiently curious and interesting to warrant a more extended examination and to this end the chloro derivatives of the mono carboxylic acid (I) and the dicarboxylic acid (see Part I.) were investigated, with results which showed clearly the manner in which substitution takes place in such an intra-annular tautomeric system as the one under discussion.

Chlorination of the acid (I) appears to take place more readily than bromination. In chloroform solution at ordinary temperature and with a fair excess of chlorine, the product is a mixture of di- and tri-chloro substitution products of the original acid, the former predominates in the mixture. Several attempts were made by arresting the reaction at an earlier stage to isolate a mono-chloro compound analogous to the monobrom compound to which we have referred. The solubilities, however, in many organic solvents and in water of the mono-chloro and the di-chloro compounds, are very similar to one another and to the original monocarboxylated acid, so that a mixture of all three substances is frequently very difficult to separate into its constituents by means of fractional crystallisation, and owing to this the monochloro compound could not be obtained in a pure condition by this method, but there can be no question from the experiments of Farmer, Ingold and Thorpe that the dichloro and trichloro compounds are substitution and not addition products for not only on analysis do they furnish figures in agreement with this, but the study of their decompositions gives conclusive evidence as to their nature. The mono-chloro compound is most easily prepared by treating the dicarboxylic acid with the theoretical amount

of chlorine in chloroform suspension, a carboxyl group being removed as carbon dioxide during the process. With an excess of chlorine the main product is the trichloro derivative, whilst if an intermediate amount be used a mixture is obtained from which it is possible to separate the mono and tri-chloro compounds and an intermediate fraction which probably contains the dichloro derivative. The mono-, di- and tri-chloro compounds have the structures (6) (7) and (8), which have been established by their products of hydrolysis, the mono and dibromo derivatives, there can be little doubt, have the structures analogous to (6) and (7), in which chlorine is replaced by bromine.



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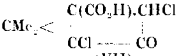

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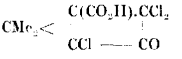

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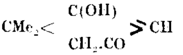


(IX)

The type of decomposition undergone by all these substances on treatment with dilute alkalis is much the same in all cases. It may be illustrated with regards the monobromo derivative which is decomposed in accordance with the equation

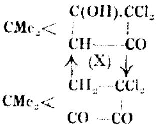
$$C_8H_9O_3Br + NaOH = C_7H_{10}O_2 + NaBr + CO_2$$

Although the carboxyl present in the original substance has evidently been eliminated as carbon dioxide, the product which is beautifully crystalline and separates from water in large, well-defined prisms, is strongly acidic and causes a vigorous evolution of carbon dioxide from sodium bicarbonate and titrates as a monobasic acid in the presence of phenolphthalein. For a time the nature of this acid was somewhat obscure, but ultimately it was discovered that it gave an intense red colouration with ferric chloride, an observation which rendered it evident that the substance was the enolic form of dimethycyclopentanedione (IX) and therefore the lower ring homologue of dimethyldihydroresorcinal, which, as is well-known, titrates as a monobasic acid, gives a strong reaction with ferric chloride and shows a remarkable tendency to separate from water in large, well-defined crystals. Fortunately, it was an easy matter to show that the acid had the structure (IX) for Vorlander (*Berichte*, 1899, XXXII., 1878), has shown that dimethyldihydroresorcinol may be oxidised nearly quantitatively to ββ dimethlyglutaric acid and chloroform by means of sodium hypochlorite. And consequently, the cyclopentane analogue (IX) should yield as dimethlysuccinic acid and chloroform when treated with alkalone hypochlorite under similar conditions. Actually the acid (IX) is converted by means of hypochlorite into as dimethylsuccinic acid and chloroform in a nearly quantitative yield.

The mechanism of the formation of (IX) from the monobromo derivative is clear, the carboxyl group has been eliminated and the elements of water added at the bridge bond and hydrogen bromide eliminated. The correctness of the structure (VI) for the monochloro derivative is confirmed by the fact that it is formed from the dicarboxylic acid with the elimination of a carboxyl group from the position into which the chlorine atom enters.

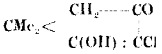
When the dichloro acid is treated with dilute alkalis, a decomposition takes place which is strictly analogous to that of the monobromo derivative. The product being an acid which gives a colouration with ferric chloride and titrates well.

Alkaline hydrolysis of the trichloro acid (VIII) pursues an interesting course; it was thought that if the trichloro acid pursued a course analogous to the other derivatives it would give a product which would split off hydrogen chloride in two ways either to give an acid which is a dichloro substitution product of the parent 1 : 3 diketone, or a substance (X). It is clear that the two substances are easily distinguished (See *J.C.S.*, 1922) for whilst the first is a stable monobasic acid, the second is the tautomeric form of dichlorodimethycyclopentadione (XI) to which it is related as anthranol is to anthrone :



(XI)

However, as it has been shown by Norris and Thorpe (*Jour. Chem. Soc.*, 1921, CXIX., 1202) that gem dihalogen derivatives of dihydroresorcinol are spontaneously reduced in alkaline solutions to monohalogen compounds with the elimination of hypochlorous or hypobromous acids, it is to be expected that the dichloro derivative (XI) of the five carbon ring analogue of dimethyldihydroresorcinal would behave similarly and in the presence of acids would pass into the monochloro derivative (12):



(XII)

and this is what occurs actually. The monochloric acid (XII) was identified by synthesising it from the parent substance dimethylcyclopentenolone by direct chlorination. These reactions clearly prove that the original trichloric acid has the structure assigned to it, and further that the three acids (VI) (VII) and (VIII) although they are most conveniently represented by the assigned bridge formulæ, can also be expressed by double-bonded formulæ in the cases of the mono and dichloro derivatives.

If one adopts the generally accepted views relating to the mechanism whereby substitution occurs in tautomeric systems, it is possible to express the production of the chloro acids by a mechanism which consists merely in alternately adding two atoms of chlorine and eliminating hydrochloric acid, leading to orientations for the successive substitution products in complete accordance with the facts. It is true, of course, that in order to obtain this result it is essential to use both the bridged and the unsaturated forms of the tautomeric substances involved, the orientation of the halogen compounds and their decompositions with alkalis therefore supply remarkably clear and convincing evidence for the view that the whole chemistry of these substances can find an adequate basis only in a dynamic conception of the constitution of the cyclic system which is their common nucleus. It appears probable that the bridged forms, however, in every case are responsible for the hydrolytic decompositions brought about by dilute alkalis; this is clear from what has been written and it is for this reason that the non-tautomeric trichloro compouns (VIII) and the two tautomeric compounds (VI) & (VII) react analogously. The importance of the non-tautomeric trichloro derivative (VIII) in connection with the evidence for tautomerism is obvious, and is similar in nature to the importance of the *O* and *N* methyl ethers of isatin in connection with the tautomerism of that substance. For by successive substitution of chlorine, the potentially mobile hydrogen atom has at length been displaced, leaving a definitely non-tautomeric derivative of the bridged modification of the tautomeric parent substance. Clearly then, the trichloro derivative (VIII) is the counterpart of the coloured diketonic acid (V) which is an equally non-tautomeric derivative of the unsaturated modification of the same tautomeric parent.

The formation of these non-tautomeric compounds by the substitution of appropriate groups for hydrogen in each of the individuals composing the original tautomeric system, taken together with the action of oxidising agents on the parent acids and the formation of oxidation products which are clearly derived from the bridged and unsaturated phases of original substance, constitutes the first evidence which was adduced in 1922 by Thorpe, Ingold and Farmer for the phenomenon of intra-annular tautomerism.

With regard to the necessity for a dynamic conception, it follows that no certain conclusions can be drawn from the reactions of any of this series of compounds as to which formula expresses the constitution of the substance in the solid state. Thus the original monocarboxylic acid (1 or 2) has been isolated in one modification only and it is not possible to tell whether this has the bridge structure in either form, although an attempt to do so was carried out by Farmer, Ingold and Thorpe which, unfortunately, was unsuccessful.

Highbury New Park, N.5.

Death of Sir John Burchmore Harrison, C.M.G., M.A., F.I.C.

PROFESSOR OF CHEMISTRY AND DIRECTOR OF THE DEPARTMENT OF SCIENCE AND AGRICULTURE, BRITISH GUIANA.

We regret to record the death at the age of 69 years, of Sir John B. Harrison—a scientific man of wide attainments, and a valuable servant of the British Empire. He was one of the oldest subscribers of the *Chemical News*, having directly subscribed to it for over fifty years, and been a reader for five years longer. He was thus a *Chemical News* reader since the age of 14 years.

Sir John Harrison was born in Birmingham on May 29, 1856, the son of Mr. John Harrison, of Wilmslow, Cheshire, and he was sent to Edgbaston Proprietary School, and having obtained a scholarship at Christ's College, Cambridge, he took his degree with a second-class in the Natural Sciences tripos of 1877. In 1879, he went out to Barbados as Island Professor of Chemistry and Agricultural Science. During his tenure of the post, he travelled for geological purposes in the West Indian Islands, and in the interior of British Guiana, and was awarded the balance of the Wollaston Donation Fund by the Geological Society of London. In 1889 he was appointed Government Analyst and Professor of Chemistry, British Guiana, and the post of Director of the Department of Science and Agriculture was added in January, 1905. Sir John Harrison—he created C.M.G. in 1901 and knighted in 1921—was specially thanked by the Secretary of State on several occasions for his services to tropical agriculture. He also received the thanks of the United States Government for his work while on special service in that country on questions of sugar analysis. He was the author of many reports and papers dealing with agricultural chemistry of tropical products and with the geology of the West Indian Islands and British Guiana. He married, in 1881, M. E. Hortense, daughter of Mr. J. P. Carter, of Barbados, and had one daughter, the wife of Mr. H. A. Frere, of Roydon Hall, Norfolk.

A bare recital of his services shews that he was a valuable public servant, a scientific man of the practical kind, who reflected credit on the public service and on science and art, while his researches in the realms of tropical agriculture have proved beneficial to British Guiana and the Empire generally.

It is appropriate that we reprint the following from the *Chemical News* of August 7 last (1925):—

INTERESTING SCIENTIFIC RESEARCH WORK IN DEMARARA.

SIR JOHN HARRISON, C.M.G., M.A., F.I.C.,

DIRECTOR OF SCIENCE AND AGRICULTURE AT GEORGE TOWN, SHEDS LIGHT ON THE CAUSE OF AN OLD EXPLOSION.

In the Chemical News of May 29, 1925, page 344, we published a brief note of a very interesting investigation in connection with a peculiar explosion in 1916 in an abandoned gold quartz mine. The investigation took place early this year, and in furnishing the memoranda specially to the *Chemical News*, Sir John Harrison says:—

"I have been a subscriber to the *Chemical News* for fifty years, and a reader of it five years preceding my regular subscription to it."

Several difficulties had to be overcome before the experiment referred to could be carried out. Sir John says it was impossible to obtain samples of the gas which produced the explosion, and proceeds:—

"Upon personal examination of the mine I could find no indication acceptable to general ideas of the occurrence of fire-damp therein. I formed a theory, and to test whether or not that theory was reliable, I took samples from the actual mining timbers at the site of the explosion and placed them under similar conditions to which they had been during the time the mine was water-logged. I proved that mining timbers under water in anærobic conditions evolved fire-damp.

The analysis of the gas gave the following results:—

Temperature 8° C. = 82.4° F.

Hydrogen	29.6
Methane	5.76
Ethane	Nil
Oxygen (free)	Nil
Carbonic oxide	Nil
Carbonic anhydride... ...	8.4
Nitrogen	3.3
Water vapour	1.1

The gas was therefore a mixture of approximately two volumes of methane (light carburetted hydrogen or marsh gas) with one of hydrogen and contained in addition about 10 per cent. of carbonic acid gas with a small proportion 3 per cent. of nitrogen probably derived mainly from the nitrogen dissolved in the water with which the jar was filled.

The residual gas in the jar after making the various tests and completing the analysis, was ignited in the presence of the Commissioner and Assistant Commissioner of Land and Mines, and of Mr. R. Ward, M.B.E., the latter of whom, as mentioned earlier, was present during the official inspection of the mine after the accident. A gush of flame arose to the height of over four feet. This demonstration completed the inquiry.

Discovery of a New Metal.

Sir John Harrison also sends us particulars of the discovery of a native Palladium Mercuride in British Guiana.

The mineral in question is, according to high authorities in mineralogy, a hitherto unknown and unique one. Its greatest peculiarity is its very high density—15.37 in my most perfect specimen. This high density is a characteristic of a compound of approximately 35% of palladium and 65% of mercury. This density points to a very extraordinary molecular condensation having taken place during the combination of the palladium and the mercury. The other characteristic mineral in alluvial deposits, in which the Palladium Mercuride is found, is diamond.

BOARD OF TRADE ANNOUNCEMENT.

Dyestuffs (Import Regulation) Act, 1920.

The Board of Trade announce that Mr. H. C. Crawshaw, of Wormalds and Walker, Ltd., Dewsbury, has been appointed a member of the Dyestuffs Advisory Licensing Committee in place of Mr. A. Wadsworth, resigned.

General Notes.

A REAL CANADIAN GOLD MINE.

Although a complete accounting of the income of Hollinger gold mine for 1925 has not yet been made, it is evident that the gross income reached approximately $16,000,000. As near as may be estimated, the income was made from a recovery of $.820 per ton from a total of approximately 1,900,000 tons of ore treated, added to which was income from other sources of about $450,000. Operating profits reached about $7,000,000, making an aggregate of nearly $7,500,000 for the year. Net profits for the year were nearly $1,000,000 above the former best record.

BLUE GLASS FOR FURNACE WORK.

A blue glass which will absorb the ultra-violet rays has, says the *Gas-Age Record*, been developed by the United States Bureau of Standards for protecting the eyes of foundrymen and other furnace workers. Safety engineers have insisted that men working around open-hearth or other high-temperature furnaces should use a brown glass which reduces the intensity of the light from the furnace, and also offers good protection against the ultra-violet rays. However, the furnace operators themselves prefer a blue glass, regardless of the fact that it only gives partial protection against the ultra-violet rays—maintaining that they can observe furnace conditions better through a blue than through a brown glass. This prejudice is probably due to their greater experience with a blue glass, because brown glasses are now being extensively used with satisfactory results in some industries. The blue glass recently made by the Bureau has, in addition to the colour and other desirable properties of the ordinary blue glass, the very desirable property of burnishing protection against the ultra-violet rays. The glass can be made by replacing about half the lime in a soft soda-glass with cerium oxide, and adding sufficient cobalt oxide to get the desired colour.—*Gas Journal.*

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.

Award of Medals and Scholarships.

The Boverton Redwood Medal—

The Boverton Redwood Medal for

Sessions 1923-24 and 1924-25 has been awarded to Mr. C. H. McCarthy-Jones, M.I.Mech.E., M.I.E.?., M.Inst.P.T., for his paper entitled "Electricity Applied to the Winning of Crude Petroleum, with Special Reference to the Yenangyaung Field, Burma," which was read on February 12, 1924, and is printed in No. 42 of the Journal of the Institution.

Students' Medal and Prize—

The Students' Medal and Prize for 1925 has been awarded to Mr. Ernest Clark (Student of the Petroleum Technology Course, Royal School of Mines, Imperial College of Science and Technology), for his paper entitled "Organic Theories of Oil Origin," and it is hoped that Mr. Clark will be able to read this paper at the General Meeting of the Institution, to be held at the House of the Royal Society of Arts on May 11 next.

The Institution's Scholarships—

The Institution's Scholarships for 1925 have been awarded as follows :—

Royal School of Mines, Imperial College of Science and Technology, London—Mr. J. O. Tanner; University of Birmingham—Mr. C. J. Ward.

UNITED STATES BUSINESS CONDITIONS.

Business activity in the United States has declined somewhat, but remains above a year ago, commodity prices are rising, stocks are reasonably firm, and money rates are easy. December exports were 468 million dollars and imports 394 million dollars, against 446 million dollars, and 333 million dollars in the last month of 1924. The year's total exports were 4,909 million dollars, and imports 4,224 million dollars, leaving an export balance of 685 million dollars, as compared with one of 981 million dollars in the preceding year. Business failures in January numbered 2,296, against 2,317 a year earlier.

GOLD MEDAL FOR EINSTEIN.

On February 12, the gold medal of the Royal Astronomical Society was conferred upon Professor Albert Einstein, in recognition of his Theory of Relativity.

In thanking the donors, he says :—

"He who discovers a line of thought which permits us to penetrate even a little deeper into the eternal mystery of nature is greatly privileged. He who, in addition, is encouraged by recognition, sympathy and help from the best minds of his time experiences more happiness than anyone can realise. In this spirit I thank you from the bottom of my heart for the great honour of which you have found me worthy."

RECENT DISCOVERY OF LITHIA MINERAL DEPOSITS IN MANITOBA.

The lithium-bearing minerals lepidotite, spodumene, amblygonite, and montebrasite, have been mined sporadically and on a small scale for at least 55 years, first in Saxony and Bohemia, and later in France, Spain, Sweden and the United States. In Canada, the first three of these minerals were known to occur sparingly and at a few localities only, until quite recently. In July, 1924, an outcrop of massive lepidotite was discovered about one mile south of Winnipeg river, approximately 10 miles east and a little north of Points du Bois. This latter point is the site of the city of Winnipeg hydro-electric plant, and is about 100 miles by railway north-east of Winnipeg. Within the last six months spodumene and montebrasite and a number of other rare minerals from this locality have also been identified; several additional deposits containing small percentages of these lithium minerals have been discovered near the original location, and it is believed that future prospecting will uncover other and similar deposits in south-eastern Manitoba and in Western Ontario. The Manitoba lithium deposits are the only ones of possible commercial value known within the British Empire.

BOARD OF TRADE ANNOUNCEMENT.

DYESTUFFS (IMPORT REGULATION) ACT, 1920.

APPLICATION FOR LICENSES IN JANUARY, 1926.

The total number of applications received during the month was 581, of which 509 were from merchants or importers. To these should be added 24 cases outstanding on the 31st December, making a total for the month of 605. These were dealt with as follows :—

Granted—475 (of which 442 were dealt with within 7 days of receipt).

Referred to British Makers of similar products—96 (of which 73 were dealt with within 7 days of receipt).

Referred to Reparation Supplies available—16 (all dealt with within 2 days of receipt).

Outstanding on January 30, 1926—18.

Of the total of 605 applications received, 513, or 88 per cent., were dealt with within 7 days of receipt.

PROCEEDINGS AND NOTICES OF SOCIETIES.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

At a meeting held at the Rooms of the Rayal Society of Arts on February 9, the following paper was read:—

The Sulphur Compounds of Kimmeridge Shale Oil. By FREDERICK CHALLENGER, D.Sc., Ph.D., F.I.C., JOHN HASLAM, M.Sc., A.I.C. (late Dalton Scholar of the University of Manchester), RANDLE JAMES BRAMHALL, B.Sc., AND JAMES WALKENDEN, M.Sc.

The technical literature contains many references to the difficulty experienced in removing the sulphur compounds which are present in the crude Kimmeridge shale oil of Dorset.

So far as the authors are aware, the numerous attempts to reduce the percentage of this undesirable element have been made without any knowledge as to the mode of combination of the sulphur. Although there is much to be said in explanation of this mode of procedure, it can hardly be considered as the one most likely to lead to satisfactory results.

The considerable success which was achieved in the removal of sulphur compounds from American petroleum long before their constitution was established is, as is well known, due to two main reasons. First, to the stable, saturated character of most of the hydrocarbons of which American petroleum is composed, and their consequent stability towards sulphuric acid. Second, to the relatively small content of sulphur compounds exhibited by most American oils and by petroleums in general. The sulphur compounds of these oils are soluble in concentrated sulphuric acid probably, as would appear from the work of Mabery and of Thierry, without chemical change since on dilution of the "acid sludge" they may be recovered.

In the case of shale oils the high percentage of unsaturated hydrocarbons greatly increases the loss during refining, since these compounds are readily soluble in sulphuric acid forming acid sulphuric esters, which are in many cases stable in presence of water and are subsequently lost. It has been shown by Heusler that neutral esters of sulphuric acid $SO_2\ (OC_nH_{2n+1})_2$ may be formed and under certain conditions may remain in the oil, actually causing an increase in its sulphur content. The elimination of sulphur dioxide, which is occasionally observed on distillation of "refined" oils, is probably due to the decomposition of these dialkyl sulphates.

In 1917-18, Meyer and Meyer showed that under conditions possibly comparable with those existing in coal, shale or lignite retorts, the interaction of acetylene and hydrogen sulphide gave rise to many derivatives of thiophen, such as thionaphthen and thiophthen. In the course of a somewhat similar investigation, Steinkopf, from the products of the action of acetylene on pyrites, isolated thiophen and various methyl-, dimethyl- and ethyl-derivatives, several of which have been observed during the course of this research.

This being the case, it was not surprising that between 1915-19 Scheibler came to the conclusion that shale oils from the Tyrol and from the South of France contained derivatives of thiophen. His purification of the oils, involving repeated treatments with sodium or sodamide, and with magnesium methyl iodide seems unnecessarily complex, but he finally obtained fractions rich in sulphur which combined with mercuric chloride. From one of these fractions by treatment with acetyl chloride and aluminium chloride, he obtained a ketone containing sulphur. Analysis of the semicarbazone indicated the possible presence of a propylthiophen methyl ketone, though the analyses agreed equally well with a methyl ketone derived from a trimethyl- or a methylethylthiophen. This established for the first time the presence of a thiophen derivative in a shale oil.

SOCIETY OF GLASS TECHNOLOGY.

The January meeting of the Society of Glass Technology was held in Manchester and extended over two days. Two sessions for meetings were held in the College of Technology, the first on Wednesday, January 20, 1926, and the second on January 21. During the morning of January 21,

members of the Society had the privilege of visiting the works of the Metropolitan-Vickers Electrical Co., Ltd., at Trafford Park, Manchester.

The first session was devoted to a general discussion on "Refractory Materials for Glass Making," introduced by Mr. E. A. Coad-Pryor, with a paper entitled :—

The Use of Refractories in the Glass Industry.

He suggested that a meeting of manufacturers might well be held annually to discuss failures and new proposals. He referred to the making and firing of tank blocks which were used in the building of three different furnaces. In two furnaces the blocks were failures, in the third they were quite satisfactory. In other tests, blocks made from mixtures containing widely different percentages of grog, and built into one furnace, exhibited not the slightest difference when a post-morten examination of the tank was made. Great differences were observed in blocks from different makers, but having the same porosity, refractoriness and nearly the same firing temperatures. The mode of operation of a furnace and the kind of clay used seemed to be very important factors in the behaviour of a refractory material. Failures due to underfiring were not so common as formerly, but flaws due to faulty moulding still occurred. The X-ray examination of blocks was advocated as a means of detecting flaws, the cost of a suitable equipment being given as £350 to £500. He thought that users would pay 10s. per ton more for blocks examined in this way, and a central testing station might well be instituted. Mr. Coad-Pryor also suggested that makers of blocks should supply some of a standard size to be built into a number of furnaces for trial runs. Again, a small experimental tank might be built, and when it was put out, a special committee might hold an examination of the various blocks employed in it.

Three other papers were presented, namely :—

Some Experiments upon the Development of Sillimanite Refractories for Glass. By W. Angus McIntyre.

Careful selection of bond clay was necessary, the choice finally resting upon a Stourbridge old mine clay which developed a good crystalline bonding of secondary sillimanite after two hours' firing at 1,420°. Specimens were immersed in soda-ash, salt-cake, potash-lead and fluorspar batches, and were seen to be much more resistant than ordinary tank blocks, fine grained sillimanite showing the best results. A selected mixture when made up into small pots for melting special soda-lime glasses at temperatures of over 1,500° C., showed very little signs of attack.

The Manufacture of Some Experimental Tank Blocks and their Behaviour in Service. By W. Angus McIntyre.

The author described experiments with a small tank furnace built entirely of the blocks to be compared. The chief defects to be overcome were bad size and shape, laminations, feeble bonding, under-firing, and black-coring, suggesting the desirability of using a high grog content, new moulding methods and thoroughly controlled firing. In the author's tests, two fireclays wers used, and two groups of blocks were made, siliceous and sillimanite, the former being further subdivided into two series with graded and ungraded grog. The furnace was run on an ordinary soda-lime batch for about six weeks. The sillimanite blocks were practically unattacked, whilst the remainder, the more siliceous blocks were generally superior to the others.

Note on a Design for a Glass Pot-Board. By F. Winks, M.Sc.Tech.

The author described an arrangement designed by him to prevent the cracking of closed pots across the hood.

At the second session, two papers were presented :—

Some Tests on Bottle Glasses with the View to Prescribing Standards of Composition. By H. S. Blackmore, B.Sc.,Tech., and Professor W. E. S. Turner, D.Sc.

In presenting this paper, Professor Turner observed that it was desirable to fix upon a rapid test which could be applied under works conditions by a person not particularly expert. The present paper was an interim report on the results of tests of 5 sets of bottles of different compositions. Three tests were employed.

(a) Boiling in the bottle a 0.1 per cent. solution in pure water of narcotine hydrochloride, and examining the solution every two or three minutes to ascertain if there was deposit of narcotine.

(b) Boiling the bottle for six hours and noting

1.—The amount of alkali extracted;
2.—The appearance of the bottle.

(c) Colour test. A solution of $\frac{N}{5,000}$ H_2SO_4, with a coloured indicator such as phenol red or bromolthymol blue, was added to the bottle and boiled.

In the case of bottles containing less than 8 per cent. of lime, test (a) definitely picked out unsatisfactory bottles. In the case of the boiling water tests there appeared to be some differences in the results obtained. The importance of temperature in carrying out durability tests was emphasised, and it was remarked that individual bottles, though treated in the same way, appeared often to have characteristics of their own. Examination of the bottles after boiling for six hours was suggested as a rapid works test, those which were satisfactory developing no pittings, the unsatisfactory ones showing such pittings more or less extensively.

The Homogeneity of Glasses Melted in Pots under Manufacturing Conditions. By Edith M. Firth, B.Sc., and Professor W. E. S. Turner, D. Sc.

Professor Turner, who presented this paper, directed attention at the outset to several factors which operated against homogeneity, *e.g.*, the varying grain size of the raw materials used, their different melting points and their varying decomposition temperatures. Reference was made to Faraday's observation in 1829 that there was a noteworthy difference in density between the top and bottom layers in a pot. Again in 1900, Jackson and Rich concluded that there were lighter and denser parts to all glasses. The present investigation was concerned with test on glasses melted under fairly well specified commercial conditions, without stirring. Several types of glasses were obtained from a number of factories and were tested, namely, (1) alkali-lead oxide glasses; (2) soda-lime-silica glasses; (3) Potash-lime-silica glasses; (4) Potash-lime-baryta-alumina boric oxide glass. Of these glasses, samples were taken as follows, (a) From the top of the pot when the glass was just ready for working; (b) from the middle of the pot; (c) from the bottom layer worked, *i.e.*, about 4 inches from the bottom of the pot. The general conclusion reached was that non-stirred commercially produced glass had a surprising homogenity of composition throughout the pot in which it was melted.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

Lord Desborough presided over the monthly Council meeting held on February 3, 1926.

Mr. Luddington reported his election as chairman for the year. A list of samples received during the months of December, 1925, and January, 1926, had been submitted by the Consulting Chemist. Dr. Voelcker had reported on the present position of the Fertilisers and Feedings Stuffs Draft Bill, and that he had received a memorandum embracing the proposals on which a Bill to be shortly introduced would probably proceed. In his opinion these adequately reflected the views of the Departmental Committee on which he had represented the Society.

Various matters arising out of his correspondence had been submitted to the Committee by Dr. Voelcker.

Sir Douglas Newton said that he would like to testify to the great value of the work which was being done by Dr. Voelcker in analysing fertilisers and feeding stuffs. A case came to his notice a few days previously in which £30 had been recovered as a result of an analysis undertaken by Dr. Voelcker. It would be well if more members of the Society could be induced to consult Dr. Voelcker when they were purchasing fertiliesrs and feeding stuffs. He was sure that it would be a great financial advantage to them to do so.

Research Committee.

A Research Committee was formed for the recording each year in a concise form, and in language easily understood by the non-scientific but practical man, of all results of agricultural research work carried out in any part of the world, either definitely negative, of present importance, or likely to be of value in the future. That we wished the volume also to contain information of value to county agricultural organisers, professors of colleges and others engaged in lecturing. And that in order that the publication might be of value as a reference book to scientists in future years, ample references should be given and indices supplied showing from what journals, bulletins, etc., the information had been drawn.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

The Annual General Meeting of the Society was held at the Chemical Society's Rooms, Burlington House, on Wednesday, February 3, when the President, Mr. G. Rudd Thompson, delivered his annual address.

The following were elected as Officers and Council for the year 1926:—

President—E. Richards Bolton; *Past-Presidents*, serving on the Council—Leonard Archbutt, A. Chaston Chapman, Bernard Dyer, P. A. Ellis Richards, Alfred Smetham, G. Rudd Thompson, E. W. Voelcker, J. Augustus Voelcker; *Vice-Presidents*—R. L. Collett, C. H. Cribb, E. M. Hawkins; *Hon. Treasurer*—Edward Hinks; *Hon. Secretary*—F. W. F. Arnaud; *Members of Council*—L. K. Boseley, H. E. Cox, John Evans, C. A. Hill, L. H. Lampitt, H. T. Lea, T. Macara, S. E. Melling, E. H. Merritt, W. H. Simmons, J. Sorley, J. White.

An Ordinary Meeting of the Society then followed, the President, Mr. E. R. Bolton, being in the chair.

Certificates were read for the first time in favour of Messrs. Sydney Back, B.Sc., A.I.C.; Howard Henry Bagnall, B.Sc., F.I.C.; William Percival Crocker; Bernard William Alfred Crutchlow, B.Sc., A.I.C., Alec Munro Ferguson, M.A., B.Sc., A.I.C.; Ralph Henry Klein, A.I.C.; Oswald James Napier, M.A., A.I.C.; George Stubbs, C.B.E., F.I.C.; Joseph Hughes Williams, B.Sc., F.I.C., F.C.S.; Kenneth Alan Williams, B.Sc., A.I.C.

Certificates were read for the second time in favour of Messrs. Guy Chignell, B.Sc., A.I.C.; Hugh Gower Watts, B.Sc., A.R.C.S., A.I.C.; and Dr. K. Saito.

The following were elected Members of the Society: — Messrs. John Douglas Barrett, B.Sc., A.I.C.; Arthur Lerrigo, B.Sc., F.I.C.; Oscar Adolf Mendelsohn, B.Sc.; Harold Edward Monk, B.Sc., A.I.C.; Eric Voelcker, A.R.C.S.

The following papers were read and discussed :—

The Determination of Copper in Foodstuffs. By L. H. LAMPITT, D.Sc., F.I.C., E. B. HUGHES, M.Sc., F.I.C., C. H F. FULLER, AND P. BILHAM.

The colorimetric method of determining copper as ferro-cyanide has been found more suitable than any of the other colorimetric methods tried. It is accurate to within about 5 per cent. A more exact method has been based on the fact that quinosol in neutral solution gives a quantitative precipitate with copper (Cu = 18.55 per cent.), in which one atom of copper appears to replace two atoms of hydrogen in the quinosol molecule. Metals not precipitated by ammonia in excess do not give a precipitate with quinosol. The precipitated copper determined by drying and weighing the precipitate or by an electrolytic method.

The Occurrence of Arsenic in Apples. By H. E. COX, M.Sc., Ph.D., F.I.C.

Attention was first directed to the recent outbreak of arsenical poisoning of apples, due to spraying with lead arsenate, as the result of two cases of illness. Only 5 out of 39 samples of Jonathan, King David and Newtown apples were found to be free from arsenic, and 11 contained more than the statutory limit. The contamination is mainly, but not entirely, confined to the skin, arsenic having been found in the flesh of the fruit to the extent of about 3 per cent. of that on the skin. Notwithstanding statements to the contrary, it appears that rain does not remove all the arsenic. Washing under the tap and even scrubbing was found to leave appreciable amounts of arsenic on the fruit; presumably owing to combination of the arsenic with the proteins of the skin.

The Direct Titration of Thallous Salts with Potassium Iodate. By A. J. BERRY, M.A.

Thallous salts are quantitively oxidised to the thallic condition by potassium iodate in presence of a sufficient concentration of hydrochloric acid. The iodine liberated is oxidised to iodine monochloride, the hydrolysis of which is prevented by the hydrochloric acid. The end-point is found by frequently shaking the liquid with chloroform, the violet colour of the dissolved iodine disappearing when the reaction is complete. The presence of bromides does not interfere, the oxidisation of the iodine being complete before any liberation of bromine occurs.

The Hot Springs at Nasavusavu. By C. H. WRIGHT, M.A., F.I.C.

The water from the hot springs of Nasavusavu in Fiji contains mainly the chlorides of calcium and sodium, with smaller quantities of magnesium, potassium, sulphate and silica. It has maintained this general composition since 1876.

The Determination of Ascaridole in Chenopodium. By H. PAGET, B.A.

The usual methods of determining ascaridole by physical tests are liable to error owing to the presence of physiologically inactive products of ascaridole, and they may fail to detect certain adulterants. A method has been based on the reduction of ascaridole, which is an organic peroxide, by a standard solution of titanous chloride. Two samples of chenopodium oil thus examined contained 72 per cent., and 80 per cent. of ascaridole, whilst a third, which answered the requirements of the U.S. Pharmacopœia, contained only 48 per cent., and was found to be adulterated with cineole.

NOTICES OF BOOKS.

The Basis of Modern Atomic Theory. By C. H. DOUGLAS CLARK, B.Sc., D.I.C., Assistant Lecturer at the University of Leeds. XIX + 292 pp. Price 8s. 6d. net. London: Methuen and Co., Ltd.

This work is, for the size, comprehensive and readable. It comprises the salient features of atomic theories recently enunciated. Clearness is successfully aimed at by the author, and his ambition is aided by many excellent illustrations and tables. The Bibliography list is generous and the indices of authors and subjects are full.

The Use of Solvents in Synthetic Organic Chemistry. By DONALD W. MACARDLE. VIII + 218. Price 15s. net. London: Chapman and Hall, Ltd.

Following the lead of Lassar-Cohn and Wehl, the well-known German writers, the author has produced a work or compiliation which merits a place in the scientific man's library. The author confesses that he was at one time tempted to confine his labours to a translation of the German works referred to above, but a work of that kind would not be satisfactory without many alterations and revisions to bring it up to date, and a work of that nature would not, probably, prove so satisfactory as the present work, in the writing of which the author has placed under generous tribute the German authors Lessar-Cohn and Wehl. The author has also been materially helped by several librarians, who assisted him in locating many helpful publications. Very naturally in a work of this kind, the Bibliography and index of authors are exhaustive.

FORTHCOMING EVENTS.

ROYAL SOCIETY.

Thursday, February 25, at 4.30 p.m.

GEOLOGICAL SOCIETY OF LONDON.

Burlington House, W.1.

The next Ordinary General Meeting of the Society will be held on Wednesday, February 24, 1926, at 5.30 p.m., when the following communication will be read:— "The Geological Structure of Ben Lawers and Meall Corranaich (Perthshire)." By Miss G. L. Elles, M.B.E., D.Sc., F.G.S.

The Annual General Meeting of the Society will take place on Friday, February 19, at 3 p.m. The Fellows and their friends will dine together at Pagani's, 6—7, Little Portland Street, W.1., on the same evening, at 7.15 for 7.30 p.m.

ROYAL MICROSCOPICAL SOCIETY.

20, Hanover Square, London, W.1.

The section of the Society which has been formed to deal with the "Industrial Applications of the Microscope," and to assist in the development of Scientific Research in British Industries, will hold its next meeting at 20, Hanover Square, W.1., on Wednesday, February 24, 1926, at 7 p.m., for 7.30 p.m. Professor H. E. Armstrong, Ph.D., LL.D., D.Sc., F.R.S., will preside.

7.30 p.m.—Messrs. Kodak, Ltd., will give a practical demonstration of the Eastman Colorimeter.

8 p.m.—Mr. C. A. Klein will read a communication: "The Application of the Microscope to the Examination of Pigments and Paints.'

ROYAL SOCIETY OF ARTS.

Monday, February 22, at 8 p.m. (Cantor Lecture). G. W. C. Kaye, O.B.E., D.Sc., Superintendent, Physics Department, National Physical Laboratory, "The Production and Measurement of High Vacua" (Lecture II.).

Wednesday, February 24, at 8 p.m. (Ordinary meeting). Mrs. Mary Fishenden, Fuel Research Board, "Domestic Heating."

On Thursday next, February 25, at a quarter past five, Dr. C. D. Ellis will begin a course of three lectures at the Royal Institution on the "Atom of Light and the Atom of Electricity," and on Saturday,

March 6, at three o'clock, Sir Ernest Rutherford commences a course of four lectures on the "Rare Gases of the Atmosphere."

THE FARADAY SOCIETY.

Ordinary Meeting, Monday, February 22, 1926, at 5.30 p.m. in the Rooms of the Chemical Society, Burlington House, London, W.1. Papers to be read :—

A. J. Allmand and R. H. D. Barklie : "The Influence of Alternating Currents on the Electrolytic Corrosion of Iron."

A. N. Campbell : "The Direct Oxidation of Manganous Ion to Permanganate."

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THE CHEMICAL NEWS,

VOL. CXXXII. No. 3437.

MERTON HOUSE, SALISBURY SQUARE,
LONDON, E.C.4.

TELEPHONES :
Administrative : Central 6521.

Printing Works : Hop 2404.

THE CHEMISTRY OF THE POLYCYCLIC STRUCTURES IN RELATION TO THEIR HOMOCYCLIC UNSATURATED ISOMERIDES. PART III.—THE SIMULATION OF BENZENOID PROPERTIES BY THE FIVE CARBON INTRA ANNULAR NUCLEUS.

By R. F. HUNTER, M.Sc., A.R.C.S., D.I.C.

The investigations which were discussed in Part II. of this series lead to the conclusion that in certain five carbon nuclei there exists a condition of tautomerism characterised by reversible interchange between bridged and cyclic phases the individuals being related to one another as the Kekulé and Dewar bridged phases of benzene. It will be remembered that part of the evidence cited by Ingold in favour of his view (*Jour. Chem. Soc.*, 1922, CXXXI., 1133), that the aromatic nucleus contains a system of bridged and Kekulé double bonded phases, consisted in the unification to which his view leads of the characteristic reactions of the aromatic series, for instance, of the formation of ortho and para quinonoid structures by oxidative and additive reactions, migrations to ortho and para positions, substitution rather than addition of halogens and so forth. It is to be expected therefore, that the five carbon prototype of the aromatic nucleus will, if the intra annular phases sufficiently resemble the double bonded Kekulé phases and bridged Dewar phases of benzene in stability, tend to simulate the truly aromatic type in the possession of the characteristics we have already mentioned, and the purpose of the investigation of Ingold, Seeley and Thorpe, which it is proposed to discuss in this part of this series of papers, was to show that it is possible so to adjust the stability of the double bonded and bridged phases of the five carbon intra annular nucleus, that certain suitable compounds of the series, do actually simulate in a marked degree, the properties of aromatic compounds.

The earlier experiments of Ingold and Farmer (*Jour. Chem. Soc.*, 1920, CXVII., 1362), which were discussed in this Journal (*Chem. News.*, 1924, CXXVIII, 209), and the experiments of Thorpe, Ingold and Farmer (*loc. cit.*) on intra-annular tautomerism existing in five carbon nuclei, were largely concerned with a series of substances derived from an acidic hydroxy ester, all the observed transformations of which can be referred to one or other of the formulæ (I) and (II).

$$\begin{matrix} CH_3 & & C(CO_2Et)C.CO_2Et \\ & >C< & \vdots \quad\quad \| \\ CH_3 & & C(CO_2Et)COH \end{matrix}$$

(I)

$$\begin{matrix} CH_3 & & C(CO_2Et) : CCO_2Et \\ & >C< & | \\ CH_3 & & C(CO_2Et) : COH \end{matrix}$$

(II)

From this parent substance, a number of others were prepared, each of which was characterised by the possession of a twofold series of properties, which if considered as evidence of structure point with almost equal directness to two structures related in the manner of the formulæ (I) and (I). The most strikiug feature of the series was the remarkable stability of the bridge phase which is well demonstrated by the oxidation of the dimethyldicyclopentanonedicarboxylic acid discussed in Part I. (*loc. cit.*) to caronic acid by means of potassium ferricyanide, whilst on treatment with alkaline potassium permangante, the acid reacted in its double bonded tautomeric modification to give αα dihydroxy ββ dimethylglutaric acid and oxalic acid, in the former case, the cyclopropane ring surviving although a considerable portion of the molecule was oxidised away. It is scarcely necessary to point out that a reaction such as the oxidation of the gem dimethylcyclopentanonedicarboxylic acid to the gem dimethyl cyclo propane acid referred to above, is unusual ,for a bridge bond, like a double bond, is ordinarily an element of unsaturation and is the point at which the oxidising agent commences its attack.

Hence, in these exceptional circumstances, in which the bridge phase is remarkably stable, it is possible to effect oxidative degradation by such agents as potassium ferricyanide and hydrogen per-

oxide in such a way as the bridge bond and hence the cyclopropane ring survives. For the purpose which Ingold, Seeley and Thorpe had in view, therefore, it was clearly necessary to adopt some means of reducing the stability of the bridged phase in the five carbon intra annular nucleus to a point at which, as in aromatic compounds, the attack of the oxidising agents begins at the para bridge bond as in the oxidation cyclis 1 : 4 diketones ,analogous to para quinones would be the first isolable products.

The method which first suggested itself, for the bringing about of this desired result was to replace the gem dimethyl group in the ester (I) or (II) by a more bulky grouping such as the methyl ethyl grouping or the residue of a cyclohexane ring, and at the commencement of their investagation, Ingold, Seeley and Thorpe had experimental evidence at hand to show that the cyclohexane derivatives were eminently suitable for the purpose. For it will be recalled that it was previously shown by Profs. Ingold and Thorpe in connection with their researches on the formation and stability of spiro compounds (*J.C.S.*, 1919, CXV., 320) showed on theoretical grounds that the bridge linking in derivatives of cyclohexanespirocyclpropouecyclobutane in which the three membered cyclopropane ring and the four membered cyclobutane ring are joined by two carbon atoms common to both, and the remaining carbon atom of the cyclopropane ring is the spirane carbon atom, must be considerably weaker than in the gem dimethyl series. This point has been fully discussed previously in connection with the hypothesis of flexible and strained valencies in Part I. of the series of articles which have appeared on the spiro compounds (*Chem. News*, 1924, CXXVIII., 389). It will be remembered that Ingold and Thorpe confirmed these theoretical considerations with regards the stability of the bridge bond in the cyclohexanespirocyclopropanecyclobutane and *gem*-dimethylcyclopropanecyclobutane ring systems, by quantitative measurement in reduction experiments (*loc. cit*).

The influence of the six membered cyclohexane ring in diminishing the stability of the bridge bond to the point at which the condtion of the structure has so far approached that of the aromatc nucleus as to give rise to a definite simulation in the properties became evident at the outset of the research.

The first experiments had for their object to determine the behaviour of the structure on oxidative fission, and is was at once discovered that although the gem dimethyl compounds yield cyclopropane derivatives, that is, undergo oxidative fission in which the bridge bond is left intact, the corresponding cyclohexane derivatives give no trace of the analogous cyclohexanespirocyclopropane 1 : 2 dicarboxylic acid, which was well characterised by Thorpe and Ingold during their work on the spiro compounds. In the place of this well-characterised cyclohexanespirocyclopropanedicarboxylic acid, the cyclohexane derivatives give cyclic unsaturated 1 : 4 diketones analogous in constitution to the paraquinones.

All attempts to isolate similar 1. 4 diketones in the gem dimethyl series were fruitless, the sole product being caronic acid, the gem dimethyl analogue of the cyclohexanespirocyclopropanedicarboxylic acid previously characterised by Thorpe and Ingold (*loc. cit.*).

It will be recalled that in the gem dimethyl series, the dibasic acid on oxidation with alkaline ferricyanide gave an excellent yield of caronic acid (*Chem. News*, 1924, CXXVIII., 209) ,on the other hand, the analogue in the cyclohexane series, 5 cyclohexanespirodicyclopentan 3 one 1 : 2 dicarboxylic acid (III) on treatment with the same reagent was converted into the diketone 5 cyclohexanespirocycloΔ^2penten 3 ol 1 : 4 dione (IV) in nearly quantitative yield, by the addition of oxygen at the bridge of the bridged phase of the substance.

$$C_5H_{10} : C < \begin{array}{l} C(CO_2H)C.CO_2H \\ | \qquad\qquad \| \\ CH —— C.OH \end{array}$$

(III)

$$C_5H_{10} : C < \begin{array}{l} CO\ CH \\ \qquad \| \\ CO\ C.OH \end{array}$$

(IV)

It is noteworthy in this connection, in these oxidations by means of ferricyanide, that although the reaction takes such different courses in the gem dimethyl and cyclohexane series, that in neither case does the product contain any substance derived from the double bonded phase of the original dibasic acid. It is evident, that in both cases the double bonded phases are stable

to this particular reagent, the attack being directed at the bridged phases alone, with such different results in the two series.

A similarly strong selective action was shown by alkaline potassium permanganate, which attacks only the double bonded phases. Thus alkaline permanganate was found by Ingold, Seeley and Thorpe to attack the double bonded phase of the cyclohexane dibasic acid, (V), to give α Ketocyclohexane 1 : 1 diacetic acid (VI), and oxalic acid

$$C_5H_{10} : C < \begin{matrix} C(CO_2H) : C.CO_2H \\ CH \! = \! = \! = \! C.OH \end{matrix}$$

(V)

$$C_5H_{10} : C < \begin{matrix} CO.CO_2H \\ CH_2 \ CO_2H \end{matrix}$$

(VI)

The reaction is exactly similar to the oxidation by means of alkaline permanganate in the gem dimethyl series, it will be remembered that the corresponding gem dimethyl acid yields α keto ββ dimethlygultaric acid and oxalic acid on oxidation with alkaline permanganate. In these two cases ,it will be noted, that neither product of oxidation contains any substance which is derived from the bridged phase, whence it is evident that the action of potassium permanganate, in both series, in contrast to that of potassium ferricyanide exerts a powerful action on the double bonded phase alone.

A similar remarkable difference iu the manner of oxidative fission of the bridged individual was observed in the case of the monobasic acid, it will be remembered that in the gem dimethyl series, ferricyanide attacked both the bridged and double bonded forms, a small yield of caronic acid derived from the bridged form, being accompanied by a large quantity of dimethylaconitic acid (*loc. cit.*) the product of oxidation of the unsaturated isomeride. In the cyclohexane series, 5-cyclohexanespiro dicyclopentan 3 one 1 carboxylic acid, the cyclohexane analogue of the gem dimethyl monobasic acid already discussed, also yielded two products, the first being the cyclic analogue of dimethylearonic acid, namely β-1-Dicarboxy β-1-cyclohexaneacrylic acid.• The other product, however, was not the cyclic analogue of caronic acid, that is, cyclohexanespirocyclopropanedicarboxylic acid, no trace of which could be detected by Ingold, Seeley and Thorpe (*Jour. Chem. Soc.*, 1923, CXXIII, 853) in the product of oxidation ,but was the same quinone-like substance which forms the sole product in the oxidation of the dibasic acid by the same reagent, that is, 5-cyclohexanespirocyclo Δ^2 penteen 3 ol 1 : 4 dione. This shows, therefore that the influence of the cyclohexane ring is sufficient to decrease the stability of the bridge bond the bridged phase of the intra annular five carbon nucleus, to the point where the five carbon nucleus simulates the truly aromatic type in the production of 1 : 4 diketones analogous to the quinones of the aromatic series, the attack of the oxidising commencing at the bridge bond, as it commences at the para bridge bond in the Dewar phase of benzenoid substances to give para quinones. These reactions are typical of a number described by Ingold, Seeley and Thorpe, which show clearly, therefore, that quinone-like substances are the normal oxidation products of the bridged modifications of this series containing the five carbon

In the oxidation of 5-cyclohexanespirodicyclopentan 3-one 1-carboxylic acid by means of alkaline potassium permanganate, the strongly selective action of this reagent on the double bonded phase is revealed, the unsaturated tautomeric form of this acid reacting with this oxidising agent to give β1-dicarboxy β1-cyclohexaneacrylic acid as the sole product.

Another somewhat remarkable illustration of the analogy between the intra annular five carbon nucleus and the truly aromatic type is revealed by the behaviour of the former towards halogens, the tendency of the compounds being to undergo substitution on treatment with halogens, the tendency being such that in every case investigated, treatment with suitable quantities of halogen under almost any condition leads to the successive and ultimately the complete replacement of all the nuclear hydrogen atoms, the reaction taking place in every instance without the least sign of the formation of isolable additive products.

The formulæ (II) and (IV) for the tautomeric forms of the dibasic acid show that in this compound there is only one nuclear hydrogen atom, namely the one in position 4. Treatment with two atoms of bromine, therefore, results in the introduction of bromine into this position, the product being similar in all essential respects to the

original acid, for instance, giving a yellow sodium compound, a strongly coloured iron salt, and the fact that it contains a similar intra annular tautomeric system is shown by its oxidation with ferricyanide, the products of which are 5-cyclohexane-spirocyclo Δ^2 penten 3-ol 1 : 4 dione and a comparatively small amount of aconitic acid.

In the monobromo dibasic acid discussed above, that is 4 brom 5 cyclohexanespiro-dicyclo pentan 3 one 1 : 2 dicarboxylic acid, the only replaceable hydrogen atom is that on which the enolic properties of the compound depend and further substitution therefore entails substitution of the mobile hydrogen atom by way of which ketoenol tautomerism takes place, and hence must be accompanied by ketonisation.

$$C_5H_{10}.C<\begin{matrix}C(CO_2H)C.CO_2H\\ \vdots \qquad\quad \Vert\\ C\,Br\text{———}C.OH\end{matrix}$$

(VII)

The product of further bromination can, therefore, no longer contain an intra annular tautomeric nucleus and must, therefore, be either a static bridged structure or a cyclic unsaturated compound according as ketonisation takes place through the one form or the other. Experiment showed that ketonisation took place through the bridged form, for the compound on oxidation with ferricyanide gave the bromo derivative of 5 cyclohexanespirocyclo Δ^2 penten 3 ol 1 : 4 dione, no trace of aconitic acid suggesting the presence of the unsaturated isomeride could be detected.

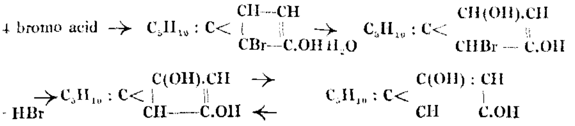
This method of suppressing intra annular tautomerism by enforced ketonisations through the substitution of bromine for the mobile hydrogen atom, recalls the case of tribromophenol which might theoretically become ketonised either by way of the Dewar bridged of Kekulé double bonded phases of the aromatic nucleus, but is actually ketonised by the former, the sole product of further bromination being the static ketone (*Jour. Chem. Soc.*, 1923, CXXIII., 859).

In the case of 5-cyclohexanespirocyclo-pentau 3 one 1 carboxylic acid, the first bromine also enters the position 4, to give 4 bromo 5 cyclohexanespirodicyclopentan 3 one 1 carboxylic acid or the unsaturated tautomer of this, which on oxidation with ferricyanide gives a large yield of 5 cyclo-hexanespirocycloΔ^2 penten 3 ol 1 : 4 dione together with a small quantity of aconitic acid. The second bromine atoms enters the position (II), to give 2 : 4 dibromo 5 cyclo-hexanespirodicyclopenten 3-one 1 carboxylic acid, which is also a tautomeric substance and resembles its precursor yielding on oxidation a small amount of bromodi-carboxycyclohexaneacrylic acid and a considerable quantity of brominated diketone. Further bromination leads to the suppression of intra annular tautomerism, the tri-bromo substitution product being 2 : 2 : 4 tribromo 5 cyclohexanespirodicyclopentan 3 one 1 carboxylic acid, a static dicyclic ketone which on oxidation passes into the bromo semi quinone, this being the sole product.

The reaction clearly takes place by way of a dibromo triketone (VI) the tendency of which to acquire the hydrogen atom necessary for tautomerism is so great that spontaneous reduction takes place in the presence of alkali.

During the earlier investigations of the gem dimethyl dicyclopentane derivatives, it was observed that certain halogen derivatives analogous to those which have been discussed above can be converted by boiling alkalis into remarkable series of compounds, the dienolic forms of which are analogous to resorcinol. A number of compounds of this type were obtained by Ingold, Seeley and Thorpe in the cyclo-hexanespirodicyclopentane series. Like phloroglucinol, they are partly ketonised, and although oximes were not obtained, titration with bromine indicated a mono-enolic formula, whilst titration with alcoholic sodium ethoxide indicated a dihydric enol. All the compounds of this series were found to form coloured iron salts yield dyes when coupled with diazotised aromatic bases in alkaline splution and indeed exhibit remarkably similarity to their aromatic analogues.

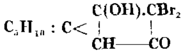
The modes of formation of these enols are of interest in so far as they involve the elimination of hydrogen bromide from the 1 : 4 positions of the ring, a type of transformation which is extremely common in the aromatic series. The formation of the simplest of the enols (VIII) or (VIII) from 4 bromo 5 cyclohexanespirodicyclopentan 3 one 1 carboxylic acid by boiling alkali must involve the following steps,



(VIII) (IX)

and may be likened to the formation of anthracene and its 9 alkyl derivative from the hydroxy dihydro compounds. It also seems possible that the formation of resorcinol by the action of alkali at higher temperature on ortho derivatives of phenol or benzenesulphonic acid is due to an analogous transformation involving bridged modifications although, as has been pointed out (*ibid.*) the devising of a crucial experiment to test this view presents obvious difficulties. The production of 4 bromo 1 : 3 dihydroxy 5 cyclohexanespirodicyclo Δ^2 pentene from 2 : 4 dibromo 5 cyclohexanespirodicyclopentan 3 one 1 carboxylic acid takes place by way of the double bonded modification of the nucleus, and to this extent, resembles, perhaps, the formation of resorcinol from para substituted phenols.

The isomeric 2 bromo 1. 3 dihydroxy 5 cyclohexanespiro dicyclo Δ^2 pentene is obtained either by brominating 1 : 3 dihydroxy 5 cyclohexanespirodicyclo Δ^2 pentene (VII) or (VIII) or by the alkaline hydrolysis of the tribromo monobasic acid, 2 :2 : 4 tribromo 5 cyclohexanespirodicyclopentan 3 one 1 carboxylic acid. This acid is a static bridged ring keto acid and, therefore, it is to be expected that the course of its hydrolysis would be generally similar to that of the hydrolysis of the monobromo acid, which reacts in the bridged form. A consideration of the matter shows that the reaction very probably does take this course, and thereby gives rise to a substance (IX), the tendency of which to acquire the mobile hydrogen atom necessary for tautomerism is such that spontaneous reduction occurs in the presence of alkali, hypobromite being formed in the solution



(X)

The alkaline hydrolysis of 4 bromo 5 cyclohexanespirodicyclopentan 3 one 1 : 2 dicarboxylic acid presents no special interest, the probable course of the reaction being the same as the case of the monobromo monobasic acid, 2 : 4 dibromo 5 cyclohexanespirodocyclopentan 3 one 1 : 2 dicarboxylic acid, however, although it is a non-tautomeric bridge ring compound ,gave rise to a mixture of both isomeric bromenols already described, and it is nothworthy that this observation falls well into line with the mechanism suggested for the whole series of hydrolytic transformations.

Highbury New Park, N.5.

SUMMARY OF THE PAPER BY H. KREFFT ON THE CANAL RAYS OF HYDROGEN, OXYGEN AND NITROGEN.

(*From the Journal of the Science Association, Maharajah's College, Venkataramiah, S. India.*)

Previous observers have found that the distribution of velocities of charged atoms in canal rays of hydrogen according to analysis by electromagnetic methods and spectrographic observations on the Doppler displacements of the Balmer series of lines —for example $H\beta$—which are radiated from neutral atoms are different. If v_0 is the maximum velocity of the particles in canal rays and V is the voltage in the discharge tube in which the canal rays are produced, then for charged atoms, $v_0 = 1.22.10^6 \sqrt{V}$ cm/sec., whereas, for neutral atoms, v_0 does not increase above a certain value, however much the voltage may be increased. Krefft's investigation on the Doppler displacements for $H\beta$ in the canal rays of hydrogen, does not support the latter observation. He finds that v_0 is proportional to $\sqrt{V}$, though it is smaller than the value given above for charged atoms.

In Krefft's apparatus, the canal, 160 mm. long and 2 mm. in diameter, is bored in a cylindrical brass cathode. Difference of pressure between the gas in the discharge

tube (Entladungsrohr) and that in the observation tube (Beobachtungsrohr) is maintained by pumping with mercury diffusion pumps attached to the canal itself. The three pumps are particularly necessary, when the gas in the observation tube is different from that in the discharge tube and should not be allowed to mix with the latter. In order to keep the discharge pure, fresh gas is made to stream continuously into the two tubes, according to a contrivance by W. Wien, through long capillary tubes. For potentials from 15,000 up to 70,000 volts, this arrangement worked well. The light emitted $H\beta$ was photographed in a spectrograph, having a dispersion of 56.9 A. per mm. For lower potentials, from 1,400 to 35,000 volts, it was necessary to take a shorter canal 22 mm. long and in the form of a slit. A spectrograph having a dispersion of 27.75 A per mm. was used.

Krefft has also studied the Doppler effect of spark lines 4592 and 4254 of oxygen, with a special dispersion of 20.6 A and 14.3 A per mm. respectively. The Doppler effect of the spark line 4530.3 A of nitrogen, with spectral dispersion of 19.35 A per mm. is illustrated. Between limits 5000 A and 4400 A, Doppler effect has been noticed for the following lines of nitrogen :—

5005.7	4643.4	4601.3	4432.0
5002.7	4630.9	4530.3	

It will be seen that the Doppler effect of the spark lines of oxygen and nitrogen are similar, but strikingly dissimilar from the arc lines (Balmer series) of hydrogen as regards the broad minimum of intensity separating the Doppler effect from the undisplaced lines in the former, while for the latter, it is very small.

The difference between the velocities of the charged hydrogen atoms in electromagnetic analysis and of the neutral atoms according to the Doppler effect is explained by the observations of Ruttenauer and Ruchardt, with homogeneous canal rays, that the ratio of charged to uncharged atoms in the rays, increases rapidly with increase of velocity. Thus, the Doppler effect of the Balmer lines has a small minimum and the intensity confined to smaller velocities, while the Doppler effect of spark lines (*i.e.*, from charged atoms) a large one and the intensity confined to those of greater velocities. That the Balmer lines of hydrogen are arc lines and the lines of oxygen and nitrogen, studied here, are spark lines have been proved by W. Wien from direct observations of electrical displacement. The Doppler effect can thus be utilised as was also shown by Stark to distinguish arc lines from spark lines. Further, it explains why the ratio of the velocities of the maxima of intensities in the Doppler effect is greater than $\sqrt{2} : 1$. About the dependence of the mean free path of light emission, with velocity, for Balmer lines nothing definite can be said, except that it is not so great as it was once thought to be.

When canal rays of hydrogen are passed through oxygen or nitrogen, the intensity of the light emitted from the moving particles is increased and the intensity of the undisplaced line very much diminished. In nitrogen, the maximum of intensity due to particles of higher velocities is increased a little, while in oxygen it is a little diminished.

If, however, the hydrogen in the discharge tube is mixed with other gases particularly with oxygen, the intensity in the Doppler displacement confines itself to lower velocities, although there is always a minimum separating the displaced from the undisplaced line. This illustrates also the influence of gas admixture in modifying the occurrences in cathode fall.

The presence of the two maxima of intensities in the Doppler effect is explained by the hypothesis of Gehreke and Reichenheim (*Verh. d. D. Phys. Ges.*, 1910, p. 417) that in cathode fall, atoms and molecules are accelerated, the latter, subsequently, dissociating into atoms. Krefft has shown, by a study of the Doppler effect of the canal rays in front of the cathode, that even there, the process of charge and discharge of particles takes place causing a complicated distribution of velocities of particles of canal rays. The canal rays may consequently be used as a medium for the study of occurrences in cathode fall.

B. DASANNACHARYA.

OXIDATION OF ZINC VAPOUR BY CARBON DIOXIDE.

By B. M. O'HARRA.

(*U.S.A. Bureau of Mines.*)

The problem of the efficient condensation of zinc vapour to liquid zinc, though it has always been of great importance in zinc metallurgy, has not been satisfactorily solved. Ordinarily a large proportion of the volatilised zinc does not condense to

liquid, but is obtained as the fine dust called blue powder. Only with difficulty and by taking special precautions can this powder be caused to melt and to coalesce into liquid. consequently a second distilla- and condensation usually is necessary to obtain the zinc in liquid form.

In an ordinary retort smelting plant 20 to 25 per cent. of the retorts are required continuously for the redistillation of blue powder, and from 25 to 35 per cent. of the total zinc produced is obtained from these retorts. In other words, in the primary distillation of zinc from its ores, about one-third of the zinc vapour condenses as blue powder, and only about two-thirds as liquid zinc.

All attempts at smelting zinc ores in a blast furnace have failed, because the zinc has always been obtained as a mixture of zinc oxide and blue powder.

Most of the electro-thermic processes that have been tried have also encountered this difficulty, and but few of them have succeeded in obtaining high yields of liquid zinc from the primary distillation. The electric zinc-smelting works in Scandinavia, which are the only ones at present using an electro-thermic process on a commercial scale, have abandoned the effort to obtain liquid ziuc from the first smelting operation. Formerly, they re-distilled the blue powder produced from the primary distillation of the ore, but in reeent years have found that the powder can be melted by heating it to a temperature above the melting point and subjeeting it to rubbing action.

American metallurgists who have experimented with electro-thermic processes have progressed somewhat further and a few have succeeded in obtaining satisfactory yields of liquid zinc in one operation. W. McA. Johnson reports one furnace run in which 77.87 per cent. of the total zinc condensed was liquid. C. H. Fulton has said that no blue powder was formed during his experiments on a semi-commercial scale at East St. Louis in 1916 and 1917.

In spite of these exceptions, preventing theh formation of blue powder is still a troublesome problem in all pyrometallurgical processes for treating zinc ores, and a complete knowledge concerning the various causes of blue-powder formation would be of much value to zinc metallurgists.

Causes of Blue-Powder Formation.

A detailed enumeration of all the causes of blue-powder formation includes so many physical and chemical factors that it is difficult to correlate them properly or to determine their relative importance, but the more important of them are quite generally recognised. They may be classified as physical causes and chemical causes, for the two act quite differently; the blue powder produced by physical causes and that produced by chemical causes have decidedly different characteristics.

Physical Blue Powder.

The production of physical blue powder is largely regulated by the design and temperature control of the condenser. When zinc vapour is condensed, that which condenses at temperatures above 419° C., is contained in the molten condition, either in drops or as a liquid body; that which condenses below 419° C. forms solid crystals similar to snow or frost. From a mixture of equal parts by volume of zinc and carbon monoxide ,such as is produced in the reduction of zinc oxide by carbon, only a fraction of 1 per cent. of the zinc remains uncondensed at 419° C., so that it is theoretically possible to obtain nearly all of the zinc as liquid.

Most of the condensation normally takes place at the inner surface of the condenser walls, which, because they are continually radiating heat outward, are cooler than the vapour coming in contact with them. The zinc condenses upon this surface as liquid drops which increase in size until they coalesce and run to the bottom of the condenser to form a liquid bath. However, the zinc vapour must diffuse through the diluting carbon monoxide to come in contact with the condenser balls. This diffusion requires an appreciable time, and hence if the vapour is cooled too suddenly, or the distance through which the vapour must diffuse in order to reach the condenser walls is too great, the zinc will condense in the gas stream as minute droplets that will be carried along to the cooler region of the condenser and will solidify before they can coalesce. By cooling the vapour from a zinc retort very rapidly in a condenser that has a large ratio of volume to surface, all the zinc can be condensed as this "physical blue powder."

True physical blue powder is nearly pure zinc and contains very little zinc oxide or

other impurities. Its production is analogous to the production of flowers of sulphur, a chilled condenser being necessary. If heated under pressure in a reducing atmosphere, physical blue powder can be melted to liquid zinc.

Chemical Blue Powder.

Chemical blue powder is caused by the formation of a solid film on the surface of newly-formed minute globules of liquid zinc as condensation progresses. The film prevents the globules from coalescing to larger liquid masses, even though the temperature conditions may be correct. This film may consist of zinc oxide, zinc sulphide, or similar zinc compounds caused by such gases as carbon dioxide, water vapour, or sulphur compounds formed in the retort, or by air diffused through the walls of the retort and condenser; or it may consist simply of fine dust carried over from the retort. Chemical blue powder usually contains considerable amounts of zinc oxide and smaller amounts of other impurities.

Of the detrimental gases that tend to cause the formation of chemical blue powder, carbon dioxide is most important. There are always small amounts of it in the gases that result from the reduction of zinc ores by carbon, and under certain conditions large amounts may be present.

Conditions Giving Rise to Carbon Dioxide in the Gases Resulting from the Reduction of Zinc Ores.

Most metallurgists believe that the reduction of zinc oxide by carbon takes place in two stages:

$$ZnO + CO = Zn + CO_2$$
$$CO_2 + C = 2CO$$

Both of these reactions are reversible and the direction in which each will proceed at any given temperature and pressure depends upon the relative proportions of zinc, vapour, carbon monoxide, and carbon dioxide present.

When the temperature of a charge of zinc oxide containing an excess of carbon is raised slowly and uniformly until the zinc begins to distil, the carbon dioxide formed at the lower temperatures is largely expelled or reduced to carbon monoxide, as the temperature increases, before any zinc vapour is produced, and thereafter not more than a fraction of 1 per cent. of carbon dioxide can be formed in the presence of the excess carbon. If, however, the charge is heated unevenly, so that part of it is hot enough to produce zinc vapour while other parts are cold enough for large amounts of carbon dioxide to be formed, the carbon dioxide and zinc vapour will enter the condenser together; the carbon dioxide will tend to oxidise the zinc and a large proportion of blue powder will be formed.

Some source of oxygen is, of course, required for this formation of carbon dioxide in the cooler parts of the charge. This source may be easily reducible oxides, such as those of lead and iron. Carbon dioxide may also be produced from carbonates introduced into the charge in uncalcined calamine ores.

Heating is especially liable to be uneven in electric furnaces that heat the charge by means of an arc or by the resistance of only a part of the charge, and is most detrimental in those processes in which the residue is melted to a liquid slag, because in those processes it is difficult to provide for an excess of carbon or sufficient contact of the gases with carbon.

Because of the influence of carbon dioxide on zinc condensation, quantitative information as to the amount of carbon dioxide necessary to oxidise zinc vapour in a mixture of zinc vapour, carbon monoxide, and carbon dioxide at various temperatures is of much practical value.

To obtain this information the investigation described in the present paper was undertaken by the Bureau of Mines, in cooperation with the Missouri School of Mines and Metallurgy, at the suggestion of C. H. Fulton ,director of that school and consulting metallurgist of the Bureau of Mines. Doctor Fulton had already done some work on the equilibrium of the reaction $Zn + CO_2 \rightleftarrows ZnO + CO$, and the present investigation is to a certain extent a continuation of that work.

Summary of Investigations.

Because of the important effect of carbon dioxide on the condensation of zinc vapour in the metallurgical treatment of zinc ores, experiments were made to determine the concentration of carbon dioxide necessary to oxidise zinc vapour at various temperatures.

Although the preliminary experiments failed to give the quantitative information

desired, they proved that the required concentration of carbon dioxide increased with rising temperature. It was found that zinc oxide was reduced at 750° C. by carbon monoxide, even when carbon dioxide was present in large proportions, but that partial reoxidation took place in the cooler part of the reaction tube. The weight of zinc oxide reduced in a given time decreased with increasing ratios of carbon dioxide, and when 90 per cent. of carbon dioxide was present, the reduction and reoxidation was manifest only by a transfer of zinc oxide from the hot to the cooler part of the tube. It was furthermore found that all carbon dioxide was converted to carbon monoxide by reaction with zinc at some temperature between 750° C. and room temperature, if enough time were allowed for the completion of the reaction.

With the knowledge gained from these preliminary experiments a final series of experiments was planned, from which the desired quantitative data were obtained. These data were plotted and a curve drawn from which may be found the minimum concentration of carbon dioxide at any given temperature that will have an oxidising effect on zinc vapour under the conditions of zinc condensation in metallurgical practice.

It has also been demonstrated that the oxidation of zinc vapour by carbon monoxide is theoretically possible, though this oxidation is ordinarily of little practical importance.

General Notes.

COLLEGE OF TECHNOLOGY, MANCHESTER.

This College has issued a comprehensive prospectus for the current session. In a prefatory note it is stated that the College has developed from the Manchester Mechanics' Institution, founded in 1824, in Cooper Street, until to-day it is of University rank and attracts students from all parts of the world. The Owens College, which was opened in Manchester in 1851, has grown into the Victoria University of Manchester. A Faculty of Technology in the University was established in 1905, with the Principal of the then School of Technology as Dean of the Faculty, and with the heads of the Mechanical and Electrical Engineering, Applied Chemistry, and Architecture departments of the School of Technology as Professors of the University. The Department of Architecture is now confined to Owens College, and the head of the department of Textile Industries as a Professor of the University is now added to the Faculty, together with a number of the College lecturers who are also lecturers in the University. The Dean and the Professors are members of the University Senate. The University Courses provided by the College of Technology lead to the degrees of Bachelor and Master of Technical Science and Doctor of Philosophy (B.Sc.Tech., M.Sc.Tech., and Ph.D.).

II NATIONAL MEETING OF PURE AND APPLIED CHEMISTRY.

PALERMO, MAY, 1926.

During the spring of this year, and exactly from 23 of May next to 2 of June, the Italian Association of Pure and Applied Chemistry (Rome) will hold in Palermo, the II National Meeting of Pure and Applied Chemistry.

On that occassion it will also celebrate the centenary of Stanislao Cannizzaro's birth.

Italy has already received many important adhesions that assure the greatest success to those functions.

Inquiries to: Associazione Italiana di Chimica Generale ed Applicata; Roma 1—Via IV Novembre 154.

FRANKLYN INSTITUTE.

JOHN PRICE WETHERILL SILVER MEDALS.

The Franklyn Institute gives notice that they intend to award the above to Dr. Frank Twyman, of London (England), for his Hilger Iuterferometer, and also to Wagner Electric Corporation, with special mention of Val A. Fynn H. Weichsel, for their Fynn-Weichsel motor.

BRITISH IRON AND STEEL OUTPUT.

Production of pig iron in the United Kingdom during January, at 538,500 tons, compares with 503,400 tons in December, and was the largest since the May, 1925, output of 574,700 tons. The production of steel ingots and castings was also above that of the previous month, but below the output of November and the two preceding months.

SOIL.

The purpose of the B.D.H. Soil Testing Outfit is to enable farmers and all persons interested in agriculture and horticulture to determine the "reaction" of the soil with rapidity and ease. By means of this outfit it is possible to find out in a few moments whether a given soil requires treatment with lime in order to remove sourness and to ensure healthy crops and better production.

The B.D.H. Soil Testing Outfit affords a simple means by which the farmer can determine the state of his soil wherever and whenever he wishes to do so, without the need of any knowledge of chemistry.

DESCRIPTION OF THE OUTFIT.

The outfit is designed for actual use in the field, and consists essentially of a dropping bottle containing the B.D.H. Soil Indicator, and a specially designed porcelain boat which is divided by a partition into two unequal parts. One end of the boat is used for mixing the sample of soil with the indicator, and the smaller end for the reception of the coloured liquid which is drained off from the mixture. In addition, a small spatula is supplied for handling the soil, and mixing it with the indicator.

A sufficiency of lime in the soil is shown by the liquid remaining green, while if an abundance of lime is present, and the soil is actually alkaline, the liquid turns blue.

METHOD OF CARRYING OUT THE TEST.

Using the small spatula provided, the larger end of the porcelain boat should be about three-quarters filled with the soil to be tested. The B.D.H. Soil Indicator should then be added drop by drop to the soil until it is thoroughly wet and the indicator just covers the surface. At this stage the end of the boat containing the mixture of soil and indicator should be titltd slightly downwards in order to prevent the liquid from running into the smaller end. The wet soil should next be stirred gently but thoroughly with the spatula, the soil should be allowed to settle for a few seconds, and the boat should then be titled gently in the opposite direction, so that the surplus liquid will flow into the small well, where the colour may be observed readily.

A red colour indicates a very acid soil.
An orange or yellow colour indicates an acid soil.
A green colour indicates a neutral soil.
A blue colour indicates an alkaline soil.

The B.D.H. Soil Testing Outfit, complete with special porcelain boat, spatula, and a bottle of the B.D.H. Soil Indicator in card box, price 4s. 6d.

Spare bottles of B.D.H. Soil Indicator—2s. 6d. each.
Spare porcelain boats—1s. 9d. each.
Spare spatulas—6d. each.

The B.D.H. Soil Testing Outfit may be obtained through Chemists and Druggists, or through any dealers in chemicals and scientific instruments ,or direct from the sole manufacturers—The British Drug Houses, Ltd., Makers of Fine Chemicals, Graham Street, City Road, London, N.1.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

At the meeting held on January 28, 1926, the following papers were read:—

The Cretaceous Plant-Bearing Rocks of Western Greenland. By A. C. SEWARD, F.R.S.

In 1921 the author, with financial assistance from the Royal Society's Government Grant and the Worts Fund (Cambridge), spent rather more than two months in Western Greenland, collecting fossil plants; be was accompanied by Mr. R. E. Holttum, who ably assisted him and made large collections of recent plants. The present paper deals briefly with the geology of the localities visited, and, more fully, with the plants collected on the coasts of the Nûgssauk Peninsula, and on the south-east coast of Disko Islaud. The fossils obtained include many species previously described by Heer, most of whose type-specimens have been examined in the museums of Copenhagen and Stockholm, and compared with the illustrations in the *Flora Fossilis Arctica.*

Measurements of the Reversing Spiral in Cotton Hairs. By W. L. BALLS, F.R.S., AND H. A. HANCOCK.

The paper embodies selections from a mass of statistical data describing the dimensions and form of the spiral structures which occur in the cell wall of cotton hairs. The spirals may be dexter or sinister, and their reversals are apparently predeter-

ined during growth in length. Genetic and ordinary environmental influences do not affect the statistical peculiarities of the reversals. The final adult length of the hair and the time taken in reaching that length do affect the reversal distribution.

Nearly all the seed hairs of Gossypium begin to grow on a sinistral spiral, *i.e.*, the opposite hand to an ordinary screw thread. This basal sinistral spiral increases in length, is broken up, and later additions may be made to its fragments. Similar extension, fragmentation, and subsequent addition take place with the later dextral spiral.

The angle of the helix varies somewhat around two modal values, *viz.*, approximately 27. and 27. sinister. The local variations of the angular value are quite unaffected by inversion of the " hand " of the angle from dexter to sinister.

Dexter and sinister wall structures have been found in some hairs to have different structural properties in their resistance to collapse after the death of the cell. A tentative explanation of the causation of reversal is suggested; but attention is directed to its insufficiency and to the need for experimental evidence.

A Contribution to the Anatomy of the Ductless Glands and the Lymphatic System of the Angler Fish (Lophius Piscatorius). By R. H. Burne. Communicated by Sir Arthur Keith, F.R.S.

This paper deals with the thymus and thyroid bodies, and a system of " fine " lymph vessels with the structure of arteries.

1. The thymus body is not of the placodal type normal to Teleosts, but lies free beneath the mucous membrane of the pharynx, connected with the branchial cavity by a tube. This tube is not a duct, but more nearly resemhles the crypts characteristic of the Mammalian tonsil. Its epithelium is similar to that of the pharynx and passes by transitional stages into the reticulum of the thymic lobules.

2. The thyroid body is occupied by a large lymph sinus, into which lymph passes through valved openings from ventral and branchial lymphatics, and from which it is conveyed to the heart by the inferior jugular. This vein is devoid of its normal factors and serves simply as a lymph channel. The majority of the thyroid vesicles project into the lymph sinus being separated from containing lymph by endothelium only.

3. Distributed to mucous membrane of mouth and pharynx, and to skin of forepart of body, is a system of " fine " vessels, similar in structure to small arteries. These vessels are not part of the blood vascular system, but connect by their terminal branches with the ordinary lymphatics. In mucous membranes these connectives are valved, to direct through them a flow from the lymphatic capillary network. Connections between the terminals of the two systems in the skin are apparently not valved. The " fine " vessels contain blood or lymph, the flow of which seems to be from mucous membrane to skin and to walls of hypobranchial and other arteries. They are probably an afferent system of lymphatics, the terminal branches of which were observed in action in the fins of young Flat-fish by Jourdain.

The Development of the Calcerrous Test of Echinus miliaris. By I. Gordon. Communicated by Prof. E. W. MacBride, F.R.S.

All elements of the permanent skeleton which are laid down in the larva are traced back to a single spherical granule. This granule, with two exceptions, becomes a triradiate spicule even in the formation of a tetraradiate spine. The exceptions are in the development of (*a*) the base of a typical Echinoid spine where it becomes hexagonal (a modification of the triradiate symmetry), and (*b*) the component parts of a tooth. The development of the tetraradiate spine, the simple and the compound tube-feet discs, and the blade of a pedicellaria is new.

A suggestion as to the origin of the unusual symmetry of the tetraradiate spines is put forward and the relationship of (*a*) the sphæridium and (*b*) the pedicellaria blade to a typical spine discussed. In the post-larval development the formation of an " echinoid " triad is described, together with the changes it undergoes after its inception and the displacement of the podia (pore-pairs) from a uniserial to a triserial arrangement.

Regarding the question of " plate crushing " and resorption two phases occur, one in which resorption at the peristomial margin is fairly rapid and " plate-crushing " slow, one in which the opposite is the case, resorption at the margin practically ceasing. The second phase occurs after the completion of the perignathic girdle. The large buccal plates arise interradially, and there

are two sets of buccal tube-feet: (*a*) five primary ones which appear soon after metamorphosis and possess simple discs; (*b*) five secondary ones which possess compound discs and come from the corona, *i.e.*, they are at first ordinary ambulatory tube-feet.

THE CHEMICAL SOCIETY.

The Ultra-Violet Spectrum of the Rare Earths, Neodymium, Praseodymium, Samarium, Europium, Erbium, and Some Others. By J. H. Gardiner.

The author has examined the absorption spectra in the extreme ultra-violet of solutions of know strength of the nitrates of praseodymium, neodymium, old didymium, prepared by M. Cleve, samarium, europium, and erbium.

Simultaneously and in juxtaposition with each absorption spectrum there is produced the spark spectrum of an alloy of metals giving a series of sharp lines, the wavelengths of which are well known: these index lines produced simultaneously with the absorption photographs enable the position of any of the bands to be found with accuracy.

The ultra-violet radiation used in the work has been produced by passing a condensed spark between electrodes of metallic uranium, which gives rise to such a number of intense lines that for all practical purposes the spectrum appears to be continuous: upon this continuous background the absorption bands of the rare-earth solutions show up very plainly.

Indications have been found of slight radioactivity in the case of the earths erbia and europia.

The Application of Graphic Formulæ to Molecular Compounds, Hydration and Variations of Valency. By H. D. Carey.

The author advances a theory concerning the formulæ of molecular compounds analogous to those of ordinary formulæ.

The Inhibition of the Glow of Phosphorus. By H. J. Emeleus.

By extending Lord Rayleigh's experiments on the glow of phosphorus, it has been shown that addition to air of, ethylene, benzene, chloroform, and aniline makes it easier to blow the glow from a phosphorus surface, whilst increase of temperature reduces the effectiveness of these poisons. An analogy is thus established between inhibitions by excess of oxygen, and by stronger poisons. Both act by preventing the progagation of the glow. The mechanism of inhibition is discussed. The "glow temperature" of phosphorus in various ethylene-air and ethylene-oxygen mixtures has been systematically investigated. Inhibition extends to 90° C., which is much above the ignition temperature. A slow non-luminous oxidation occurs. The "glow temperature" does not depend on whether the ethylene is diluted with air or with oxygen.

Properties of Conjugated Compounds. Part 1. Conjunctive Associations in Extended "Conjugated" Systems. By E. H. Farmer and J. Ross.

The tendency towards the conjugated association of adjacent unsaturated elements in extended systems such as ·CH : CH·CH : CH·C : O would appear from general chemical evidence not to be uniform along the chain. Although it may be held that a state of complete conjugation is assumed during hydrogen addition, yet more often in such system reactivity appears determined by partial association of the unsaturated centres.

NOTICES OF BOOKS.

Thermal Expansion of Tungsten. By Peter Hidnert and W. T. Sweeney. U.S.A. Bureau of Standards. Price 5 cents per copy.

This paper gives the results of an investigation on the thermal expansion of tungsten (99.98 per cent.) over various temperature ranges between −100 and +500° C. A summary of available data obtained by previous observers on the thermal expansion of tungsten is included. The expansion of tungsten is given by the following empirical equation:

$$L_t = L_0[1 + (4.28\ t + 0.00058\ t^2)10^{-6}]$$

where L_t represents the length of the metal at any temperature t between −105 and + 502° C., and L_0 the length at 0° C. Average coefficients of expansion for various temperature ranges are given in a table.

The pioneer experiments of Fink on the linear thermal expansion of tungsten were followed by the work of Langmuir, Worthing, and other investigators. A summary of the results of these researches is given.

The present research was undertaken for the purpose of obtaining reliable data on the linear thermal expansion of pure tungsten. Expansion determinations were

made over various temperature ranges between −100 and + 500° C.

The authors wish to express their appreciation for the tungsten furnished by the Fansteel Products Co., North Chicago, Ill. Acknowledgment is also due to Dr. W. Souder, Bureau of Standards, for valuable suggestions.

Organic Synthesis. (Au annual publication of Satisfactory Methods for the Preparation of Organic Chemicals.) VII +110. Price 7s. 6d. net. London : Chapman and Hall, Ltd.; and New York : John Wiley and Sons, Inc.

With a septet editorial board and 18 eminent contributors, it would be surprising of no great magnitude were not authoritative and reliable (except on the domestic theory that "too many cooks spoil the broth.") The work is composed of 33 chapters, each one of which is submitted by two editors and checked by two others. With this method, reliability could scarcely be avoided and there is no doubt that the work will be welcomed by a wide circle of readers.

RECENTLY-PUBLISHED PAMPHLETS, REPORTS, Etc.

...*Report of the Cost of Production of Maize Investigation for the Season* 1922-23. By E. Parish, B.Sc., Principal, Glen Agricultural School of Agriculture, Orange Free State, Union of South Africa.

Further Investigation into the Causes Producing Rosette of Apricot and Plum Trees in the Wellington District. II. Report on Some Preliminary Investigation into the Influence of Alkali Soils on Peach Stocks Employed for Apricot and Plum Trees. By R. Marloth, Ph. D., D.Sc., Dept. of Agriculture, Union of South Africa (Pretoria).

FORTHCOMING EVENTS.

ROYAL SOCIETY.

Thursday, March 4, 1926, at 4.30 p.m. Discussion Meeting on "The Electrical State of the Upper Atmosphere." The discussion will be opened by the President, Sir Ernest Rutherford, D.M.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, W.C.

Wireless Section Meeting.—Wednesday, March 3, 1926, at 6 p.m. (Light refreshments at 5.30 p.m.) "The Directional Recording of Atmospherics," by R. A. Watson Watt; and "An Instantaneous Direct Reading Radiogonimeter" by R. A. Watson Watt and J. F. Herd.

Thursday, March 4. "Electro-farming; or the Application of Electricity to Agriculture."

ROYAL INSTITUTION OF GREAT BRITAIN.

21, Albemarle Street, London, W. 1.

Saturday, February 27, at 3 p.m. "Roman Britain (2)," by Dr. G. Macdonald.

Monday, March 1, at 5 p.m. General Meeting.

Tuesday, March 2, at 5.15 p.m. Prof. J. Barcroft : "The Yolk of an Egg."

Thursday, March 4, at 5.15 p.m. Dr. C. D. Ellis : "The Atom of Light."

The Friday Evening Discourse on March 5 will be delived by Sir Henry Maybury on "London Traffic," and on March 12 by Sir J. J. Thomson on "Radiation from Electric Discharges."

ROYAL SOCIETY OF ARTS.

Tuesday, March 2, at 4.30 p.m. Sir Basil Clarke : "Publicity."

Wednesday, March 3. Percy Dunsheath, O.B.E., M.A., B.Sc., M.I.E.E., Chief of Research Department, W. T. Henley's Works Co., Ltd., "Science in the Cable Industry." Llewellyn B. Atkinson, M.I.E.E., in the Chair.

SOCIETY OF PUBLIC ANALYSTS.

Wednesday, March 3, at the Chemical Society's Rooms, Burlington House, W.1., at 8 p.m. "The Analysis of Acetic Anhydride," by H. Droop Richmond, F.I.C., and J. A. Eggleston, B.Sc. "Notes on the Determination of Moisture, Calcium and Phosphorus in the Bones of Rats," by A. L. Bacharach, B.A., A.I.C. "An Accurate Method for the Determination of Mercury in Solution," by B. S. Evans, Ph.D., F.I.C., and S. G. Clarke, B.Sc., A.I.C. "An Apparatus for Continuous Percolation and for Filtration in Neutral Atmospheres," By B. S. Evans, Ph.D., F.I.C.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

2,780.—Barbet, E. A.—Treatment of residual liquors. January 30th.

2,398.—Banbury, H. M.—Mono-oxamic acids of diamino-anthraquinones. January 27th.

2,759.—Esseff Chemische Industrie-u. Handels Akt-Ges.—Manufacture of alkaline earth salts. January 30th.

2,666.—Fielding, Sir C. W.—Manufacture of sulphuric acid. January 29th.

3,402.—Blackburn, H. W., & Thomas, W.—Manufacture of ammonia. February 5th.

2,916.—Rath, C.—Production of 2-hydrazino-5-nitro-pyridine. February 1st.

3,275.—Farbenfabriken Vorm F. Bayer & Co.—Process for obtaining perfumes from flowers, etc. February 4th.

3,149.—Farbenfabriken Vorm F. Bayer & Co.—Maufacture of caustic alkali solutions. February 3rd.

Specifications Published.

245,479.—Harris, H.—Treatment of alkali liquors.

245,584.—Dodd, H., Sprent, Dr. W. C., and United Alkali Co., Ltd.—Manufacture and production of quinizarin.

234,086.—Soc. of Chemical Industry in Basle.—Manufacture of condensation products of the anthraquinone series.

245,708.—Karpen and Bros, S.—Manufacture of phenolic condensation products.

245,838.—Haco-Ges Akt-Ges. — Manufacture of compounds of alkaloids.

245,903.—Farbenfabriken vorm. F. Bayer & Co.—Process for the manufacture of sulphuric acid.

245,991.—Karpen & Bros. S.—Producing chlor-derivatives of methane.

241,903.—Chemische Fabrik Greisheim-Elektron.—Process for the production of phosphoric acid.

236,145.—Cederberg, Dr. I. W.—Process for the catalytic combustion of explosive gaseous mixtures.

Abstract Published.

243,925.—Synthetic drugs. — Farbwerke Vorm. Meister, Lucius, & Bruning. Hoechst-on-Main, Bockmuhl, M, 90, Konigsteinerstrasse, Unterdiederback, Hoechst-on-main, and Schwarz, A, 41, Oppenheimerlandstrasse, Frankfurt-on-Main, all in Germany.

Methylsulphites of secondary aromatic-aliphatic amines.—The process of the parent Specification for the manufacture of therapeutically-active N-methylsulphites of secondary aromatic-aliphatic amines is modified by treating a secondary aromatic-aliphatic amine (except methylaniline, ethylaniline, benzylaniline, or an N-alkylated anthranilic acid or nucleal substitution product thereof) with formaldehyde and a bisulphite in any order, or by treating a condensation product from a primary aromatic amine and formaldehyde first with an alkylating agent and then with a bisulphite, any such treatment which would lead to the N-methylsulphites of the above mentioned aromatic-aliphatic amines being excluded. Examples are given of the preparation of sodium-1-phenyl-2 : 3-dimethyl-5-pyrazolone-4-ethylamino (or methylamino)-methyl-sulphite and sodium-N-methyl-*p*-phenetidine-methylsulphite.

Methylene-bis-1-phenyl-2 : 3-dimethyl-4-methylamino-5-pyrazolone is obtained by heating with formaldehyde the mixture of amines produced by methylating 1-phenyl-2. 3-dimethyl-4-amino-5-pyrazolone. On further treatment with formaldehyde and bisulphite, it yields the N-methylsulphite of the methylamino-pyrazolone referred to above.

Methylene-bis-N-methyl-phenetidine is similarly obtained by treating with formaldehyde the crude N-Methylphenetidine obtained by methylating phenetidine. On further treatment with formaldehyde and sodium bisulphite, it yields the phenetidine methylsulphite referred to above.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

RUNSOL.

464,991.—Chemical substances used in manufactures, photography or philosophical research and anti-corrosives.—C. K. Cotton, Manor House, Tongham, Farnham, Surrey. January 27th.

BETA-BOROCAINE.

465,359.—Chemical substances prepared for use in medicine and pharmacy. —The British Drug Houses, Ltd., 16 to 30, Gresham Street, City Road, London, N.1. January 27th.

PLASTOID.

464,139.—Chemical substances used in manufactures, photography, or philosophical research and anti-corrosives.—Murphy & Sons, Ltd., The Cedars, Sheen Lane, Mortlake, London, S.W.14. February 3rd.

CODLETS.

464,785.—Chemical substances prepared for use in medicine and pharmacy.—International Chemical Co., Ltd., 7, Wybert Street, Munster Square, London, N.W.1. February 3rd.

CAUSTISCIN.

462,939.—Chemical substances prepared for use in medicine and pharmacy.—M. Woelm Aktiengeselleschaft, Lange Gasse, Spangenberg, Hessen, Germany. February 10th.

BALSANI.

464,029.—Chemical substances prepared for use in medicine and pharmacy. —R. Parkinson and Sons, Curzon Street Drug Mill, Curzon Street, Burnley. February 10th.

HALARSOL.

465,410.—Chemical substances prepared for use in medicine and pharmacy. —May and Baker, Ltd., Garden Wharf, Church Road, Battersea, London, S.W.11. February 10th.

FLAXOLYN.

465,503.—Chemical substances prepared for use in medicine and pharmacy. —H. H. Luntz., 1165, St. John's Place, Brooklyn, New York, U.S.A. February 10th.

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THE CHEMICAL NEWS,

VOL. CXXXII. No. 3438.

MERTON HOUSE, SALISBURY SQUARE,
LONDON, E.C.4.
TELEPHONES :
Administrative : Central 6521.
Printing Works : Hop 2404.

REACTION REGIONS. I.

By W. P. JORISSEN.

When we mix three substances, A, B, and C, which can react with each other (*viz.*, all three, or two by two, or two of them), there is a possibility that the reaction, started locally, propagates itself through the whole mass. This will happen if the quantity of heat developed by the reaction is sufficient to bring the adjacent parts of the mixture to the temperature necessary for the starting of the reaction.

When we gradually change the composition of the mixture we shall get, at last, mixtures in which the locally-started reaction does not propagate itself.

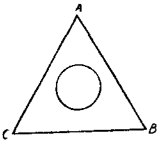

Fig. I.

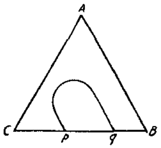

Fig. II.

By indicating the composition of the mixtures by points within a triangle, the corners of which represent the three substances A, B, and C, we get a closed curve which surrounds the *reaction region* (*Fig.* I). On raising the original temperature, the region will extend itself*. It may reach one side of the triangle (Fig. II), of two sides (Fig. III), or all three sides (Fig. IV).

* This will also happen when one of the three substances is air, and we gradually replace the nitrogen by oxygen.

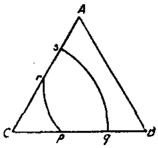

Fig. III.

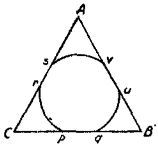

Fig. IV.

The points where the boundary curves of the reaction region reach the sides of the triangle (p and q, r and s, u and v) will indicate the limits of the reacting mixtures of two of the substances.

In the case represented by Fig. II, the reaction can propagate itself in a mixture of the substances C and B between the limits p and q.

Fig. III represents the case where also the substances C and A can react with each other, on condition that the composition of the mixtures varies between r and s.

Fig. IV. represents the case where the three substances can react with each other and also two hy two.

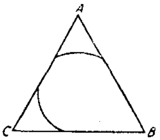

Fig .V.

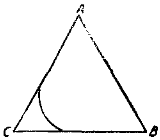

Fig. VI.

We also see the possibility that the cases represented by the Figs II, III, and IV change into each other by changing the temperature. The shape of the curves will further depend on the nature of the substances A, B, and C, and other circumstances. If *the substance* **B** *is endothermic* the reaction region can extend itself to the point B (Fig. V, as may easily be constances A and C.

The case of two endothermic substances (A and B) is represented by Fig VI.

The reaction region of three endothermic substances will fill the whole triangle when the reaction is so started that always each of the substances comes into reaction.

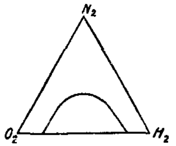

Fig. VII.

A. Let us consider now *three gases.*

a. Two of the substances can react under the circumstances, but the third one does not react under those circumstances.

Example : The explosion of mixtures of hydrogen, oxygen and nitrogen. We may expect a region as shown in Fig VII.

The lower and upper explosion limits of hydrogen in mixtures with oxygen are represented by the points of intersection of the curve with the line O_2H_2; addition of *nitrogen will bring those points nearer and* nearer to each other till they finally coincide. If we take air instead of oxygen and we consider the air as one substance (a less active oxygen) we can add carbon dioxide and will get a similar region (compare also J. K. Clement, *Technical Paper* 43, *Bureau of Mines*, 1913, in which are treated the explosion limits of mixtures of methane or natural gas with oxygen, carbon dioxide and nitrogen). A second example is given by the system phosphorus vapour-oxygen-nitrogen (or carbon dioxide, etc.). Of these reaction regions, only a few points have been determined; see W. P. Jorissen, *Rec. trav. chim.*, 1920 XXXIX., 717; 1921, XL., 539.

b. Two of the substances are able to react with the third one, apart or together. See Fig. VIII, in which the experiments with mixtures of hydrogen, ethylene and oxygen are represented. The explosion region is ADCB. (See W. P. Jorissen and B. L. Ongkiehong, *Rec. trav. chim.*, 1926, XLV., 162). The small triangles represent Davy's observations (*Phil. Trans.*, 1817, I., 59). If we take air instead of oxygen we get a much smaller region (upper limit : EF, the lower limit nearly coincides with AB). This region follows from A. G. White's observations (*J. Chem. Soc.*, 1925, CXXVII., 48).

How case *a* may be changed into case *b* is shown by Fig. IX, where the explosion regions of chloroform, methylene chloride and methyl chloride with carbon monoxide and air are drawn. (Experiments of J. H.

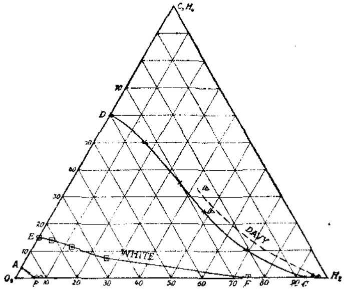

Fig. VIII.
Explosion region in hydrogen-ethylene-oxygen and in hydrogen-ethylene-air.

A. P. Langen van der Valk. See also : W. P. Jorissen and Langen van der Valk, *Rec. trav. chim.*, 1925, XLIV., 813, 1045. The explosion region of CCl_4—CO—air mixtures is *very* small (it is not drawn here); that of $CHCl_3$—CO—air mixtures is somewhat larger, AFBA; that of CH_2Cl_2—CO—air, AEBA, approaches already the left side of the triangle. The explosion region CH_3Cl—CO—air ACDBA reaches that side of the triangle; the lower explosion limit of CH_3Cl—air mixtures is represented by C, the upper explosion limit by D.

Fig. IX shows that methylene chloride at ordinary temperature has already a disposition to give explosion limits with air and we may be sure that those will be found at a higher temperature provided that the substance does not decompose before that temperature is reached.

How Fig. II can change into Fig. III, when we replace air by oxygen, is shown by experiments with hydrogen—ammonia—air and hydrogen—ammonia—oxygen mixtures. (W. P. Jorissen and B. L. Ongkiehong, *Rec. trav. chim.*, 1926, XLV., 224), see Figs X and XI.

From these figures we may conclude that the addition of nitrogen to the oxygen has only a small influence on explosion limits of hydrogen. On the other hand the explosion limits of ammonia will approach each other rapidly, chiefly by a movement of the line of the upper limits.

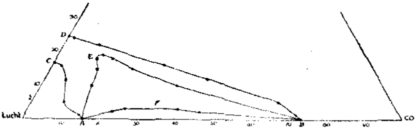

Fig. IX.

By determining the explosion limits of ammonia in mixtures of oxygen and nitrogen we found that those limits coincide when the oxygen content is about 32 per cent. Therefore, if we were to determine the explosion region in hydrogen—ammonia—oxygen (+ nitrogen) mixtures with 32 per cent. of oxygen we should see that it is enclosed by a curve, which touches the $O_2(+N_2)$-NH_3 side of triangle.

When we *determine the explosion region* at a lower oxygen content, the curve will approach more and more closely the curve of Fig. X. If the oxygen content becomes less than 21 per cent., the explosion region will become smaller and smaller and at last disappear. When we mix the ammonia with a substance which is influenced in about the same way by the addition of nitrogen to the oxygen as ammonia itself, then we should expect that the curve which encloses the explosion region ammonia—second substance—oxygen (+ nitrogen) will leave at a certain nitrogen content the O_2 (+ N_2)—ammonia side of the triangle and also the O_2 ($+N_2$)—second substance side. The explosion region will then contract to a closed curve within the triangle. (See Fig. I).

Thus it will be possible under certain circumstances (of temperature, etc.), to make explosive mixtures of *two* gases or vapours with air while each gas or vapour *separately cannot give explosive mixtures* with air under the same circumstances. In the second place we can turn our attention to vapours, such as methylene chloride, which with gases, such as carbon monoxide, and air, give an explosion region of the form drawn in Fig. IX, AEBA. In that case the vapour does not give explosive mixtures with air alone. But certain mixtures of two such vapours and air will certainly be explosive (under the same circumstances). In the third place we should expect that mixtures of two gases or vapours with air, which have at a certain temperature an explosion region as drawn in Fig. III, will have one as shown in Fig. I, at a lower temperature. Of course a favourable choice of the two gases or vapours is necessary for the success of the experiment.

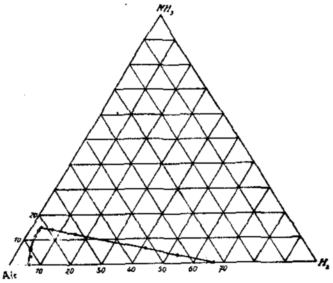

Fig X.
Explosion region in hydrogen-ammonia-air.

An investigation, the results of which may be put in practice, is that of the explosion regions in mixtures of methane, air and an *incombustible* vapour. A number of observations has been made with the vapours of CCl_4, $CHCl_3$, $C_2H_2Cl_2$, C_2Cl_4, $C_2H_2Cl_4$ and C_2HCl_5. (W. P. Jorissen and J. Velísek, *Rec. trav. chim.*, 1924, XLIII., 80; W. P. Jorissen and J. C. Meuwissen, *Rec. trav. chim.*, 1924, XLIII., 591; 1925, XLIV., 132). An extensive systematical investigation is now started in our laboratory in order to find the vapours (or gases) which give the smallest explosion regions.

Among the cases in which one of the gases is endothermic several are to be

found which have a practical value, for instance, the system acetylene—acetone vapour—air (applicable to "dissolved acetylene") and the system acetylene—saturated hydro-carbons (manufacture of carbon black).

A *case of two endothermic gases or* vapours is carbon disulphide—nitrogen oxide—carbon dioxide. The latter gas acts as *inhibitor*. Knowing the reaction region, we are able to point out the mixtures in which the reaction will travel fast and those in which the reaction will proceed at a slow pace (application : source of a constant actinic light).

c. The three gases or vapours can react two by two.

Example : Hydrogen—oxygen—sulphur vapour.

B. A well-known combination of *two gaseous substances with one solid substance* is the system methane—coal dust—air. In presence of coal dust a smaller quantity of methane is sufficient to bring about a mine explosion. This follows at once from Fig. III.

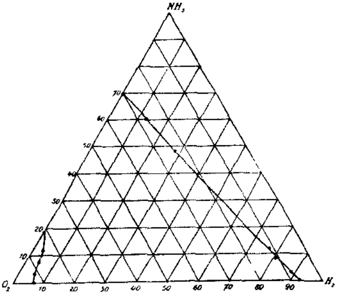

Fig. XI.
Explosion region in hydrogen-ammonia-oxygen.

Many examples are known of explosive mixtures of air and the dust of a solid combustible substance (J. Harger, *Coal and the Prevention of Explosions and Fires in Mines*, London, 1913, Chapter IX.; D. J. Price and H. H. Brown, *Dust Explosions*, Boston, Mass., 1923; P. Beyersdorfer, *Staub Explosionen*, Dresden, 1925). It will be clear that the danger increases in presence of a combustible gas. In practice this influence has been observed already (Engler, *Chem. Ind.*, 1885, VIII., 171). Also that the danger diminishes when the *oxygen content* of the air becomes smaller (Harger, *l.c.*, p. 108, 109). It will be of importance to determine the explosion *region* in such cases.

To the systems of two gaseous substances and a solid one belongs also the extinction of methane—air explosions by means of stone dust (by the "Hauptsperre" of H. and E. Kruskopf).

C. Combinations of *liquids with solids* are met with in the case of explosives used in practice. It will be worth while to study for instance the reaction regions of mixtures of porous material with nitroglycerine and some other organic substance. Also those of nitroglycerine, nitrocellulose and some stabilising substance; or those of liquid air, a porous substance and an organic compound, etc. An example is to be found also in the Brit. Patent 21850 (A.D. 1912) relating to mixtures of porous material, liquid acetylene and acetone.

D. If we wish to study the reaction region of mixtures of *three solid substances* we may also direct our attention to explosives. But there are many systems which are more suitable for our experiments. For instance, the system Fe—SiO_2—S. The reaction region will have the form drawn in figure VII (we have only to change O_2, H_2 and N_2 into S, Fe and SiO_2).

Somewhat less simple is the system Mg—SiO_2—MgO. Very interesting will be also the study of the mixtures called "thermites," and such life, for instance. Al—SiO_2—S, Al—Fe_2O_3—Cr_2O_3, BaO_2—Si—Fe, etc.

However, the results obtained with such systems will be treated in other papers, in which also stress will be laid on the velocity of reaction and the reaction temperature.

The University, Laboratory for Inorganic Chemistry,
Leiden, Holland.

December, 1925.

PLATINUM AND ALLIED METALS.

By JAMES M. HILL.

(*U.S.A. Bureau of Mines.*)

CRUDE PLATINUM.

Mine returns for 1924 indicate a production of 28 troy ounces of crude platinum in Alasa, 285 ounces in California, 20 ounces in Oregon, and 2 ounces in Utah, a total of 335 ounces for the United States. In 1923 Alaska produced 7 ounces, California 578 ounces, and Oregon 24 ounces.

Platinum refiners report purchases of domestic platinum in 1924 as follows: Alaska, 5 ounces; California, 161 ounces; Oregon, 24 ounces; and Utah, 2 ounces—a total of 192 ounces, which is 608 ounces less than was purchased by refiners in 1923. Refiners also report purchases of 64,479 ounces of foreign crude platinum in 1924—1,041 ounces from Australia, 5 ounces from Canada, 56,387 ounces from Colombia, and 7,046 ounces from Russia. As reported by the Bureau of Foreign and Domestic Commerce, the imports of platinum from Columbia during 1924 were 43,463 ounces, an increase of 10.8 per cent., as compared with imports in 1923.

REFINED PLATINUM METALS.—NEW METALS.

Reports of refiners of crude platinum, gold bullion, and copper indicate that 66,007 ounces of platinum metals were recovered from these sources in 1924, an increase of 16,210 ounces, or 33 per cent., as compared with recoveries in 1923. It is estimated that of the total quantity, 7,280 ounces was derived from domestic sources.

CONSUMPTION.

The consumption of platinum metals in the United States in 1924, as reported by refiners, was 165,018 ounces, a decrease of 14 per cent., as compared with 1923. The chemical industry increased its consumption 1,890 ounces, most of which was platinum. The electrical industry used 2,981 ounces less and the dental industry 5,285 ounces less than in 1923. The jewellery industry reduced its consumption by more than 21,000 ounces, but used more osmium and rhodium than formerly.

It will be noted that the figures for consumption of platinum metals, calculated by two methods, check rather closely as to total and for platinum. The figures for 1923 have been revised as more detailed information concerning imports is now at hand, but even with this change the estimates are still far apart for that year.

MARKET AND PRICES.—CRUDE PLATINUM.

Sellers of domestic crude platinum reported they were paid for metal content based on assay, and no figure can be given for crude platinum. Buyers reported purchases at $93 to $122 an ounce for domestic and $94 to $114 for foreign crude platinum.

LOW TEMPERATURE CARBONISATION

A CONSIDERATION OF DIFFERENT PROCESSES OPERATED IN DIRECT CONJUNCTION WITH STEAM BOILER, GENERAL FURNACE, AND POWER PLANT, ESPECIALLY IN RELATION TO THE UTILISATION OF LOW-GRADE COLLIERY FUELS.

By DAVID BROWNLIE, B.Sc. (Hons.) Lond., F.C.S., M.I.Chem.E., A.M.I.Min.E., etc.

(*Paper read before the Institution of Mining Engineers (Midland Counties Institution Section), on February 17, at the University College, Nottingham.*)

The contribution is of great length, over 30,000 words, and includes fourteen illustrations, while the author, who summarised the paper in about 50 minutes, showed over sixty specially prepared lantern slides, including many photographs of the plant described. He gives it as his opinion that the next stage of evolution in steam power station operation is the combination of low temperature carbonisation of raw coal with separation of the tar or crude oils and, if necessary, ammonia, and the combustion under the steam boilers of the residual gas, along with the smokeless low temperature fuel, either in a pulverised condition or in the solid form using travelling grate stokers. He stated that it is impossible, for example, to go on burning 8,000,000 tons of raw coal per annum under the power station boilers of Great Britain. If carbonisation as part of the boiler plant operation was adopted, this would give every year about 20,000,000 gallons of motor spirit, 120,000,000 gallons of low temperature tar, and 53,000 tons of sulphate of ammonia, while requiring 9,600,000 tons of coal instead of 8,000,000 tons for the same steam output. Many

super-power stations to-day are burning 1,000 tons of raw coal per 24 hours, and it is not much of a step to carbonise this coal, which already has to be crushed, conveyed, and stored in overhead bunkers. The same applies to other large furnaces, such as in the iron and steel, ceramic, glass, and chemical industries, and the author most strongly urges the colliery industry in Great Britain to co-operate together and study on scientific and practice lines the whole subject of low temperature carbonisation, over 100 processes being available, as in many cases smokeless fuel and by-products could be sold to much better advantage instead of raw coal, while low grade refuse fuels also are available for utilisation.

The paper is divided into the following parts and is claimed to give for the first time a comprehensive survey of low temperature carbonisation :—

(1) The pre-drying of raw fuels before combustion, carbonisation, or gasification.

(2) Low temperature carbonisation in conjunction with mechanical fixed furnaces.
   a Advantages and disadvantages of the general principle.
   b The "Julius Pintsch" process (of Berlin), using part of the furnace gases as the internal heating medium.
   c The work of Messrs. Merz and McLellan, Ltd., (of London and Newcastle, using superheated steam as an internal heating medium).
   d The "Pluto Stoker" process (of Holland, also using superheated steam as an internal heating medium).
   e "Carbocite Dual Carbonisation," or "Wisner" process (Canton, Ohio, U.S.A., using rotary retorts with oxidation of the charge).

(3) Low temperature carbonisation in conjunction with pulverised fuel firing.
   a Advantages and disadvantages of the general principle.
   b The history of the carbonisation of pulverised fuel.
   c The "McEwen-Runge" process (London and U.S.A.).

(4) The "Midland Coal Products" process (Nottingham).

(5) "Staveley Coal and Iron" or "Markham" processes (Staveley, near Chesterfield).

Each of the above processes, together with much historical matter, was described at great length, giving in many cases information and data not hitherto published. In the Julius Pintsch process of Berlin, for example, in connection with which nine plants are operating in Germany, Upper Silesia, and Norway, the coal is carbonised at 1,000-1,250° F., in front of water tube boilers, passing down continuously to the mechanical stoker hopper, by means of 35,000-45,000 cubic feet of furnace gas per ton, taken from over the top of the stoker, the total duration of the heating being about six hours. The solid smokeless fuel is then burnt on the stoker, along with the gas over the top of the fires, giving per ton a yield of 16-20 gallons of low temperature tar, 40,444 cubic feet of low grade gas, 110 B.Th.U. per cubic foot, and 1,568 lbs. of smokeless fuel (70%).

The new "Wisner" process the crushed coal is first "thermodised" in a long horizontal rotary externally-heated retort at about 500°-600° F., while a current of heated air is passed through the charke, 2,000-10,000 cubic feet per ton, the temperature being adjusted exactly so that the viscous stage is not reached. This heated oxidised coal is now carbonised at once in an adjoining rotary retort at not over 900° F., and it appears to be a new discovery, contrary to the general opinion, that coal treated in this way with air in the heated condition does not lose its coking properties. For furnace work the final smokeless fuel is passed direct to the mechanical stoker hopper, and it is claimed the process is of equal value for coke oven operation, about 40 minutes "thermodising" giving a state of advancement of the charge corresponding to 8-10 hours in a coke oven withaffecting the quality of the coke.

The author gives the results of his researches into the history of the carbonisation of pulverised coal and shows that the real pioneer in this field, as in that of pulverised fuel firing, is Thomas Russell Crampton, of London, whose British patent for carbonising pulverised coal is No. 2262/1872, to which detailed reference was made along with the life and work of Crampton. Also there was described the investigations of H. C. Bull (1883), J. A. Yeadon and T. Whittaker (1889-1895), Professor Vivian B. Lewes, A. Pinet and A. Debout, and Harry A. Kuhn.

The new "McEwan-Runge" process for the low temperature carbonisation of pul-

verised coal in front of water tube boiler and other furnaces is the invention of S. McEwen, of London, who commenced work on the subject in 1919. Subsequently the investigations were continued in the United States under the superintendence of Dr. Runge, a large scale experimental retort being erected at the Lakeside power station, Milwaukee in 1923. The problems are stated to have been solved and an extensive plant, with a capacity of 200 tons of coal per 24 hours, is now being completed at Milwaukee, sufficient to operate 25% of the station. In the "McEwen-Runge" process the pulverised coal, instead of being burnt in the raw state, is dropped down two vertical retorts in series, externally heated, each of which gives a carbonisation of 35 seconds. In the first, or pre-heating retort, the temperature averages 600° F., and in the second, 1,050° F., the volatile contents of the coal being reduced to about 10% by only 70 seconds carbonisation, because of the fine state of division. The residual fuel then passes direct to the burners, while 18-20 gallons of low temperature tar per ton is recovered, along with 2 gallons of motor spirit scrubbed from the mixed gas, which is 7,000-7,800 cubic feet at 400 B.Th.U.

The work of the Midland Coal Products Co., Ltd., of Nottingham, assocated with the well-known Butterley Co., Ltd., of Derby, is of the greatest interest in connection with the utilisation of small non-coking elacks, and the same applies to that of the Staveley Coal and Iron Jack Co., Ltd., using cannelloid colliery refuse such as "bats," "jacks," "black shale" and similar products. A detailed description of this work is given for the first time, including the experiments now being carried out to use the exhaust of a huge 7,150 H.P. gas engine, operating on blast furnace gas, for carbonisation, passed direct through the charge in a vertical intermittent retort.

General Notes.

SHIP-BUILDING PROGRESS.

The Orient Steam Navigation Company have placed an order with Messrs. Vickers, Limited, for a passenger steamer, generally similar in dimensions to the "Orama," and "Othanto," recently built by the same firm.

Messrs. Alfred Holt and Company, acting on behalf of the Straits Steamship Co., Ltd., have placed an order with Messrs. Vickers, Ltd., Barrow-in-Furness, for a fast turbine-driven twin-screw passenger vessel for service between Singapore and Penang.

THE NEW WAVE TRANSMISSION PHONOGRAPH.

Popular Radio (New York) for January, contains an exhaustive illustrated article under the above title, by Mr. Henry C. Harrison. Referring to the article, *Popular Radio* says :—

"The fundamental thing about radio is the handling of wave energy, of vibrations. Two kinds of waves are involved. From the loudspeakers and telephones come the mechanical waves of sound. In the electrical parts of radio instruments, as well as in the ether, the waves are electromagnetic ones. Many of the principles are the same. In this article Mr. Harrison describes the application of wave-energy principles to the acoustic problem of designing a high-quality phonograph. This involves "mechanical impedance," "mechanical transformers," other novel concepts which will interest every radio engineer. The research constitutes, *Popular Radio* believes, one of the greatest recent adancves in the science of sound. Facts uncovered by the telephone engineers were put at the disposal of the talking machine interests, whose researches have put them in position where the new technique could be appreciated and applied. Thus radio, often accused of having damaged the phonograph industry, actually contributes one of the greatest advances which that industry has ever made.

OBITUARY.

PROFESSOR A. R. CUSHNY.

On February 25, Professor Arthur Robertson Cushny, Chair of Materia Medica and Pharmacology in the Edinburgh University, died at the age of 60, after a brief illness.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

Papers read, Thursday, February 4, 1926.

Researches on the Chemistry of Coal. Part IV. By W. A. Bone, F.R.S. and R. Quarendon.

The paper summarises the results of the authors' recent experiments upon the oxidation, by means of alkaline solutions of potassium permanganate, of the "residues" obtained after the extraction of coals with benzene under high pressure, as described in the previous paper of the series. It is shown that such "residues" may be easily oxidised by such means, yielding a complex mixture of benzenoid carboxylic acids amounting to between 25 and 40 per cent. of the weight of the "coal-residue" treated. A method of separating and investigating these acids is described, whereby 1, 2, 3, 4 *benzene tetracarboxylic* acid and mellitic (*i.e., benzene hexacarboxylic*) acid have already been isolated and identified, the last-named in considerable quantity. Several other acids, not yet identified, have also been obtained.

Measurements of the Amount of Ozone in the Earth's Atmosphere and its Relation to other Geophysical Conditions. By G. M. B. Dobson and D. N. Harrison. Communicated by Prof. F. A. Lindemann, F.R.S.

Measurements of the amount of ozone in the atmosphere have been made almost daily throughout 1925, and a few measurements were also taken during the autumn of 1924. The average amount is about 0.3 c.m., which agrees with former measurements. A marked connection is found between the atmospheric pressure and amount of ozone, the latter being large in cyclonic and small in anti-cyclonic conditions. There is a well-mared annual period with a maximum in spring and minimum in late autumn. Other geophysical connections are probable. The probable error of observation is shown to be about 0.005 c.b. of ozone.

Ahmospheric Ozone and Terrestrial Magnetism. By C. Chree, F.R.S.

Use is made of measurements of ozone in the atmosphere taken at Oxford during 1925 by Messrs. D. N. Harrison and G. M. B. Dobson, which these gentlemen had put at the author's disposal for the purposes of this investigation. There appears to be a decided association of magnetic disturbance and higher values of ozone. Owing to the tendency to sequences of high ozone figures and of days of magnetic disturbancy, it is difficult to say exactly how synchronous the phenomena are. The figures suggest that the high ozone figure, if anything, rather precedes than follows the crest of magnetic disturbance.

Condensation of Water from the Air upon Hygroscopic Crystals. By J. S. Owens. Communicated by Sir Napier Shaw, F.R.S.

The main purpose of the paper is to describe experiments on conditions of deliquesence of crystalline matter found in air, the bearing of such formation of haze, fog and on condensation generally, and in addition the finding of means of identification crystals too small for microchemical or crystallographic examination. The special methods developed are described, as applied to pure salts, to salts from seawater and to crystals found in air.

It is demonstrated that deliquesence of crystals of pure salts depends upon the vapour pressure of their saturated solutions while mixed salts, as found in air, behave in a different manner from pure salts. One method described consists in exposure of salts to atmosphere, taking observations of temperature and humidity as these change naturally, while at the same time very minute crystals of the salts are observed microscopically.

The conditions for deliquesence obtained in this way are given for different pure salts, while reeords of crystalline matter obtained from air by means of the author's jet-dust counter are dealt with specially, including examples from mouth of St. Lawrence River, Algarve (Portugal), Sussex coast, Bournemouth, and Cheam (Surrey).

It is usually assumed that before fog can be formed the air must be saturated, or nearly so; but it is demonstrated that all the examples of crystals obtained from the air would become liquid in air very much under-saturated. Thus the Portuguese crystals collected water at 69 per cent. relative humidity at 56° F., the St. Lawrence crystals deliquesced at about 77 per cent. relative humidity at 56° F. Crystals obtained in Bournemouth deliquesced at about 67 per cent. relative humidity at 62°

F., indicating that it is not necessary for air charged with such crystals even to be near saturation for a fog of liquid drops to form.

THE PHYSICAL SOCIETY OF LONDON.

The Annual Meeting was held at the Imperial College of Science, South Kensington, London, on February 12, F. E. Smith, C.C.E., F.R.S., in the chair.

The following Officers and Members of Council were elected for the year 1926-1927 :

President—Prof. O. W. Richardson, M.A., D.Sc., F.R.S.

Vice-Presidents who have Filled the Office of President Sir Oliver J. Lodge, D.Sc., F.R.S.; Sir Richard Glazebrook, K.C.B., D.Sc., F.R.S.; C. Chree, Sc.D., LL.D., F.R.S.; Prof. H. L. Callendar, M.A., LL.D., F.R.S.; Sir Arthur Schuster, Ph.D., Sc.D., F.R.S.; Sir J. J. Thomson, O.M., D.Sc., F.R.S.; Prof. C. Vernon Boys, F.R.S.; Prof. C. H. Lees, D.Sc., F.R.S.; Prof. Sir W. H. Bragg, K.B.E., M.A., F.R.S.; Alexander Russell, M.A., D.Sc., F.R.S.; F. E. Smith, C.B.E., F.R.S.

Vice-Presidents—E. H. Rayner, M.A., Sc.D.; J. H. Vincent, D.Sc., M.A.; D. Owen, B.A., D.Sc.; Prof. F. L. Hopwood, D.Sc.

Secretaries—Prof. A. O. Rankine, O.B.E., D.Sc., Imperial College of Science and Technology; J. Gnild, A.R.C.S., D.I.C., National Physical Laboratory, Teddington, Middlesex.

Foreign Secretary—Sir Arthur Schuster, Ph.D., Sc.D., F.R.S.

Treasurer—R. S. Whipple, 45, Grosvenor Place, S.W.1.

Librarian—J. H. Brinkworth, M.Sc., A.R.C.S., Imperial College of Science and Technology.

Other Members of Council—R. W. Paul; Prof. A. M. Tyndall, D.Sc.; W. S. Tucker, D.Sc.; A. Ferguson, M.A., D.Sc.; J. S. G. Thomas, D.Sc.; D. W. Dye, B.Sc.; Sir Richard Paget, Bart.; E. A. Owen, B.A., D.Sc.; J. Robinson, M.Sc., Ph.D.; A. B. Wood, D.Sc.

The President, on behalf of the Council, presented the Duddell Memorial Medal to Albert Campbell, B.A.

Proceedings at the Ordinary Meeting following the Annual General Meeting :—

The following papers were read :—

On the Hyperbola Method for the Measurement of Surface Tension. By A. FERGUSON, M.A., D.Sc., AND I. VOGEL, B.Sc. Read by Dr. Ferguson.

When a liquid lies between two plates inclined to one another at a small angle its surface has a hyperbolic section, from measurement of which the surface tension can be calculated. The method has long been known, but has recently been improved by Grünmach. Errors arise, however, from the difficulty of determining the horizontal and vertical axes of co-ordinates, and according to the present paper this difficulty is met by plotting two linearly related functions of the observations, the surface tension being deduced from the co-ordinates of the resulting mean straight line and the angle between the plates. The latter may be measured either directly or by calibration with a liquid of known surface tension.

DISCUSSION.

Dr. J. H. Vincent suggested that in addition to avoiding errors of displacement in the co-ordinates axes, the method might yield a correction for errors in the verticality of the line of intersection of the plates.

Mr. T. Smith said that in introducing his paper the author had referred to lens-system formulæ which could be transformed so as to yield linear graphs, and had suggested that the co-ordinates of the resulting mean straight lines would give average results for the observations on which they were based. It must be remembered, however, that geometrical optics represents only an approximation to the physical facts, and that the values obtained in different regions of a range of observations have very different probabilities of error. In practice the mean adopted must be a weighted mean, which is not provided by the linear-graph method.

The Application of Radiography to the Study of Capillarity. By E. A. OWEN, M.A., D.Sc., AND A. F. DUFTON, M.A., D.I.C. Read by Dr. Owen.

The X-ray shadow of a tube has previously been used for determining the diameter of the bore. The present investigation was designed to test the suitability of a similar method for capillarity measurements, and observations were made of the rise of mercury in copper and steel tubes and between vertical copper plates. The results were satisfactory.

The Action of Hydrogen Sulphide on a Neutral Solution of Potassium Permanganate. By HORACE BARRETT DUNNICLIFF AND SUKH DAYAL NIKHAWAN.

When a solution of potassium permanganate was shaken with hydrogen sulphide solution, a brownish-black precipitate of hydrated manganese dioxide and sulphur formed immediately; the faintly alkaline filtrate contained unchanged permanganate. The precipitate was well washed by decantation with air-free water, and the manganese dioxide in it was estimated by determining the amount of chlorine it liberated from hydrochloric acid. The liquid left over from this estimation was treated with sodium carbonate, and the total manganese weighed as Mn_3O_4. Three estimations gave values of 1 : 3.8; 1 : 3.1; and 1 : 2.7 for the molecular ratio $MnO : MnO_2$, shewing that the manganese is only partly precipitated as hydrated dioxide when excess of hydrogen sulphide is passed through the solution, the hydrated manganese dioxide is converted into manganous sulphide. The solution is alkaline throughout, probably due to the absorption of the Anions of the potassium salts by the hydrated manganese dioxide.—*Abstracted from the Journal of the Chemical Society, January, 1926.*

OPTICAL SOCIETY.

At the annual general meeting of the Optical Society, held at the Imperial College of Science on Thursday, February 11, 1926, the following Officers and Members of Council were elected for the session 1926-27:

President—T. A. Smith, M.A.; *Vice-Presidents*—Inst.-Comdr, T. Y. Baker, R.N., B.A.; F. F. S Bryson, M.B.E., M.A., B.Sc.; R. S. Clay, B.A., D.Sc.; H. H. Emsley, B.Sc. *Treasurer*—Major E. O. Henrici, R.E., F.R.A.S. *Secretaries*—Prof. Alan Pollard ,A.R.C.S., A.M.I.E.E.; F. S. S. Bryson, M.B.E., M.A., B.Sc. *Librarian*—J. H. Sutcliffe, O.B.E. *Editor*—John S. Anderson, M.A., D.Sc., Ph.D. *Members of Council* — D. Baxandall, F.R.A.S., A.R.C.S.; W. M. Brett; W. B. Coutts, M.A., B.Sc., F.R.S.E.; A. H. Emerson; E. F. Fincham; J. Guild, A.R.C.S., F.R.A.S.; E. T. Hanson, B.A.; H. C. Raxworthy; J. Rheinberg, F.R.M.S., F.R.P.S.; G. F. C. Searle, Sc.D., F.R.S.; W. Swaine, B.Sc.; F. C. Watts.

The President of the Optical Society of America was elected an *ex-officio* Fellow of the Society.

At an Ordinary General Meeting of the Society, held at the conclusion of the Annual General Meeting, the following papers were presented and discussed :—

The Annealing and Re-Annealing of Glass. By W. M. HAMPTON, B.Sc., A.I.C.

PART III.—The determination of annealing temperatures.—The formulæ deduced in Parts I. and II. are applied to the case of heating glass under constant gradient and the temperature at which strain disappears is obtained, the effect of the known change in the coefficient of expansion on this temperature being discussed. The calculated and experimental curves are compared and the effect of changes in the rate of heating and in the size of the specimens is considered.

PART IV.—The annealing of glass at low temperatures.—The annealing equation is considered from the point of view of dimensions. The agreement of theory and experiment is discussed, and an explanation of the discrepancies at low temperatures is advanced. A general expression to cover all cases is deduced, which when applied, agrees well with the results of experiment.

The Nature of the Polishing Operation. By F. W. PRESTON.

The status of the "flowed" layer on glass, quartz, and similar materials which have been ground or polished, is unsatisfactory. The paper calls attention to a number of phenomena that seem to bear on this subject, and might serve as starting points for interesting researches. The evidence of the existence of a surface layer on polished glass, differing from the underlying material and from the surface layers of ground, or fire-glazed glass, or crystalline surface layers in the case of quartz, is slight or negative. Tests on the interfacial, or microscopic properties, provide no satisfactory evidence of any distinctive flowed layer, while a study of the rates of abrasion, properties of abrasives used, and defects of polishing, suggests that the polishing process is principally one of ultra-microscopic abrasion. It may be a process of abrasion complicated by the fact that the fissures produced by one grain of the abrasive lie in the territory of its neighbour, and that the abrading efforts of the several grains tend to neutralise one another.

FARADAY SOCIETY.

A Note on the Effect of the Electrode Material on Oxidation Potentials. By J. A. V. Butler, W. E. Hugh, and D. H. Hey.

(A paper read before the Faraday Society, Monday, January 18, 1926.

In the course of investigations on oxidation potentials a number of metals have been used as inert electrodes by various workers, and in a few cases some comparative measurements with different metals have been reported. But hitherto no comprehensive comparison of the behaviour of electrodes in this respect has been made and it seemed worth while to make a study of the matter.

From thermodynamical considerations it appears that so long as the electrode material takes no part in the reaction going on in the cell, and provided the system undergoes oxidation and reduction reversibly at the electrode, it can have no effect on the electromotive force. For the electromotive force is under these conditions a measure of the free energy of the cell reaction, and in this the electrode is not concerned. The question therefore resolves itself into a consideration of the range of metals at which these conditions are fulfilled.

The condition that the electromotive behaviour of the metal may not affect the oxidation potential is easily obtained. For if the oxidation potential of the system be π_1 and the normal potential or the metal π_2 and the concentration of metal ions in the solution C, the condition of equilibrium is

$$\pi_1 = \pi_2 + \frac{RT}{\nu F} \log C.$$

If this condition is not initially fulfilled, metal ions must dissolve or deposit until a state of equilbrium is reached. An oxidation potential can only be measured if no appreciable disturbance of the system occurs in this process. If we suppose in order to fix our ideas, that the solution of metal to an extent sufficient to give a concentration of metal ions round about the electrode of 10^{-7} is not objectionable on this account, it is evident that the necessary difference between π_1 and π_2 will be about $\frac{.4}{\nu}$ volts.

The range of metals which can be employed is thus limited. For reducing systems many of the metals have a sufficiently high normal potential, but for highly oxidising systems such as $Mn^{\cdot\cdot}$—MnO_4', $Co^{\cdot\cdot}$-$Co^{\cdot\cdot\cdot}$ it is doubtful whether any metal has the required property.

Evidently if the oxidation potential *measured in the complete cell is independent* of the metal M, the effects due to changes in the thermionic work function must balance at the two junctions.

For the comparison of a number of metals the extremely well-defined ferro-ferricyanide potential was first tried.

The cell,

Hg	Hg_2Cl_2 KCl, $n/1$	$K_3Fe(CN)_6$, $n/200$ $K_4Fe(CN)_6$, $n/200$ KCl, $n/1$	M

was made up with electrodes of different metals and measured in a thermostat at 25°. Electrodes of those metals which cannot be obtained in the form of foil were made by sealing globules of the metal into glass tubes with hard wax. Unless otherwise stated the electrodes were not specially treated.

It was found that with electrodes of platinum (platinised and plain), palladium, iridium, osmium, gold, rhodium, and ruthenium, a constant potential (.1905) + .0001 volts was reached within an hour of making up the cell. Electrodes of molybdenum, tungsten, nickel, silver and mercury, were prepared but in no case were constant potentials obtained. In most cases the metal was visibly attacked and soiled by the solution.

In order to be able to include a wider range of metals it was evidently necessary to use a system with a lower oxidation potential. A suitable system was found in a solution of cuprous-cupric chlorides in aqueous ammonia. In this case after some preliminary measurements in which an auxiliary calomel electrode was used, to test the constancy of the platinum electrodes, two platinised electrodes were used as standards and the potentials at electrodes of other metals were compared directly with these. The electrode solution was kept in an atmosphere of nitrogen to prevent aerial oxidation.

It was found that electrodes of palladium, iridium, gold, osmium, rhodium, ruthenium, silver, nickel and mercury quickly acquired the same potential as the platinum electrodes, within + .0001 volt. Electrodes

of molybdenum, tungsten, tantalum, arsenic, and antimony did not give constant potentials. Selenium (metallic) and graphite gave constant potentials differing from platinum by 0.3 and 0.6 millivolts respectively. These differences are probably due to incomplete reversibility at these electrodes.

The independence of oxidation potentials of the electrode material when this takes no appreciable part in the cell reaction is thus confirmed.

THE ELECTROMOTIVE BEHAVIOUR OF CUPRIC OXIDE.

By R. E. W. MADDISON.

(A Paper read before the Faraday Society, Monday, January 18, 1926.)

(Summary.)

In an investigation of the affinity relations of cupric oxide and cupric hydroxide, Allmand observed that the electrode Pt/CuO, Cu_2O-alkali, gave continuously varying potentials, the initial value depending upon the source of the vupric oxide and upon its history. The change in potential, which in every case resulted in the P.D. becoming more negative ,was at first rapid, and in the final stages asymptotic. The possibility was considered of this behaviour being due to the irreversibility of the electrode; but as the criteria of irreversibility of an electrode as set forth by Luther were not fulfilled ,some other explanation was sought. The potential of the electrode being given by the expression :

$$[E.P.]\ c_u^{\cdot\cdot} \rightarrow c_u^{\cdot} + \frac{RT}{nF} \log_n \frac{[Cu^{\cdot\cdot}]}{[Cu^{\cdot}]},$$

the fall in P.D. could be accounted for by (1) an increase in the cuprous ion concentration—a change which is not very probable; (2) a decrease in the cupric ion concentration. Decrease in solubility due to disappearance of the smaller particles, to which the initial decrease in P.D. of the elements $Pt/CH(OH)_2$, Cu_2O-alkali, and Hg/HgO-alkali had been ascribed, was found to offer no explanation in this case, Allmand, *idem*, p. 608; and a dynamic theory of allotropy was put forward, according to which the homogeneous phase of any given specimen of cupric oxide consists of various molecular species in equilibrium. Accordingly, the physical constants of the cupric oxide will vary from specimen to specimen, depending upon the history of the sample.

Wöhler suggested that the abnormal behaviour of this electrode could be quite accounted for by the formation of solid solutions of cuprous oxide in cupric oxide, the hypothesis of polymerised forms being unnecessary. Roberts and Smith, however, showed that solid solution does not occur in the system CuO-Cu_2O-O_2, in the temperature range where both oxides are solid. The results of Muer and Nakamoto agree with this. Recently, Hedvall has studied by means of Röntgen ray interference, using Debye's powder method, the structure of the oxides of various metals. Eleven specimens of cupric oxide were examined, and all gave the same interference bands, from which he concluded that amorphous forms were non-existent. He considered improbable the hypothesis of different modifications put forward to account for the varying physical properties shown by different samples of the same oxide prepared in different ways.

The work presented here represents the results of a further attempt to solve the problem of the behaviour of this electrode.

In every case the electrode measured was Pt/CuO, Cu_2O.N-NaOH, employing smooth platinum foil with mercury contacts. The electrode vessels of ordinary pattern were filled to a depth of 1-2 cms. with a mixture of cuprous and cupric oxides in about equal proportions; after filling with the electrolyte 1-2 c.c. of air remained. The auxiliary electrode was a standard Hg/HgO.N-NaOH element. By using a connecting vessel containing N-NaOH, liquid/liquid P.D.'s were avoided. E.M.F.'s were measured by the Poggendorf compensation experiments, measurements were made in a thermostat at $25° + 0.1°$ C. The electrolyte was prepared from sodium hydroxide purified by alcohol, the sticks being washed with a little water to remove the superficial layer of carbonate. Cuprous oxide was prepared as described in *Vanini. Handb. präp. Chem.*, 2nd Ed., Vol. 1., page 488. Unless otherwise stated, cupric oxide was prepared by heating copper carbonate.

In the system HgOHgO N-NaOH Cu_2O, CuO/Pt the current travels in the cell from right to left. The reaction which takes place is $HgO + Cu_2O \rightarrow Hg + 2CuO$, or ex-

pressed ionically for the passage of 2 faradays $Hg^{\cdot\cdot} + 2Cu \rightarrow HG + 2Cu^{\cdot\cdot}$.

Summary.

(1) The behaviour of the electrode Pt/Cu_2O, CuO, N-NaOH has been re-examined. Initially, it gives a relatively positive P.D., which gradually becomes more negative. The initial and final P.D.'s depend on the temperature of preparation of the oxide, and on the duration and method of heating.

(2) It has not been possible to conclude definitely for or against the hypothesis put forward by Allmand, which does, however, conflict with the work of Hedvall, who ascribes the changes in physical properties of the oxide to a filling up of gas-filled or empty spaces.

NOTICES OF BOOKS.

Qualitative Inorganic Analysis. By D. R. Snellgrove, Ph.D., M.Sc., A.I.C. and J. L. White, D.Sc. (Lecturer on Inorganic Chemistry, Battersea Polytechnic). XII + 282 pp., with fourteen diagrams. Price, 7*s.* 6*d.* *London : Methuen and Co., Ltd.*

This work has been written with the aim of assisting students persuing a course of honours B.Sc., and A.I.C. examiuations, and as the authors are practically acquainted with the difficulties confronting students under the conditions indicated, they have been able to produce a work which fulfils the necessary conditions. The work is clear and accurate without being verbose. The tables and diagrams will prove helpful in the clearing away of difficulties, the solution of which would require considerable preparation and investigation. There is a useful index and the arrangement of the solubality tables at the end of the work in the shape of indices, will prove more serviceable than if scattered over the pages in the body of the work.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.

Physical and Chemical Survey of the National Coal Resources.

An important aspect of the work on fuel research undertaken by the Department of Scientific and Industrial Research is a survey and classification of the coal seams in the various mining districts hy means of physical and chemical tests in the laboratory, supplemented where desirable by large scale tests at H.M. Fuel Research Station, East Greenwich, or elsewhere. The Fuel Research Board of the Department consider that the best way to carry out this work is my means of local committees representing the local colliery owners and managers, the local branch of the Institution of Mining Engineers, the Fuel Research Board, and the Geological Survey of Great Britain ,as well as outside scientific interests. Each committee is charged with the duty of supervising the work of the physical and chemical survey in a coal mining area; and in this way the survey becomes of practical value from the commencement, since local knowledge and experience are made available, and the seams to be investigated and the general programme of work are decided by those who are able to estimate most correctly the relative importance of the problems to be solved. The seams selected undergo physical and chemical examination by local investigators appointed for the purpose, after which a final selection is made of those seams likely to justify experiments on a technical scale in order to test their suitability for particular uses or methods of treatment.

Committees have for some time been actively at work in the Lancashire and Cheshire and in the South Yorkshire areas. A committee for the North Staffordshire area was formed last year, and the Department recently appointed a committee to deal with the coalfields of Scotland .

A further committee has now been formed to deal with the survey of the coalfields of Nottinghamshire and Derbyshire. The Midland Counties Colliery Owners' Association, the Notts and Erewash Valley Colliery Owners' Association, and the Midland Counties Institution of Engineers, are co-operating in this work.

FORTHCOMING EVENTS.

Thursday, March 11, at 4.30 p.m.

ROYAL INSTITUTION.

21, Albemarle Street, London, W.1.

Saturday, March 6, at 3 p.m. "The Rare Gases of the Atmosphere." Sir E. Rutherford.

Monday, March 8, at 5.15 p.m. "The

White of the Egg." Professor J. Barcroft.

Thursday, March 11, at 5.15 p.m. "The Atom of Light and the Atom of Electricity." Dr. C. D. Ellis.

Friday, March 12, at 9 p.m. "Radiation from Electric Discharges." Sir J. J. Thomson.

Saturday, March 13, at 3 p.m. "The Rare Gases of the Atmosphere." Sir E. Rutherford.

ROYAL SOCIETY OF ARTS.

John Street, Adelphi, London, W.C.2.

Wednesday, March 10, at 8 p.m. "The *Micro-Structure of Coal.*" *Reinhardt* Thiessen, Ph.D. (of the Bureau of Mines, U.S. Department of Commerce). Sir Thomas Henry Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S., Chairman of the Council, will preside.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

3,553.—I. G. Farbenindustrie Akt-Ges.—Manufacture of chromium compounds. February 8th.

3,722.—Flor, K., & Salzwerk Heilbronn Akt-Ges—Obtaining sulphur from alkaline earth sulphates. February 9th.

3,706.—Schestakoff, P. I.—Manufacture of naphtha-sulphonic acids and salts thereof. February 9th.

3,565-3,566.—Uhde, F.—Synthesis of ammonia. February 8th.

Specifications Published.

246,272.—Plinatus, V.—Process for dissolving and gelatinizing cellulose esters, such as nitrocellulose and like cellulose compounds.

246,377.—Badische Anilin & Soda Fabrik.—Manufacture and production of a calcium nitrate fertilizer.

246,415.—Karpen & Bros. S.—Separation of hexamethylenetetramine from ammonium chloride.

246,529.—Thomas, J., Hereward, H. W., and Scottish Dyes, Ltd.—Production of hydonxy-anthraquinones.

236,151.—Allgemeine Vergasungs-Ges. —Process of distillation of bituminous coal in several stages.

Abstract Published.

244,645.—Ammonium bicarbonate. —Badische Anilin & Soda Fabrik; Ludwigshafen-on-Rhine, Germany.

Emulsions, making; butyl and propyl naphthalene sulphonic acid.—Ammonium bicarbonate free from other compounds of ammonia and carbon dioxide is obtained by crystallising it from an initially hot aqueous solution and introducing carbon dioxide while the crystallisation continues, as the solution cools. Instead of pure carbon dioxide gases rich in carbon dioxide may be used which may also contain a small quantity of ammonia. The process is facilitated by the addition of a substance which influences the surface tension of the solution, and especially a substance which increases the surface tension. As examples of the latter are mentioned ammonium sulphide, sugar, and oily liquids such as benzene, petrol, carbon tetrachloride, iron carbonyl or oils obtained from coal or lignite tar. Propyl and butyl substituted naphthalene sulphonic acids which reduce the surface tension may also be used. They may be prepared by the interaction of propyl or butyl alcohol upon naphthalene or naphthalene sulphonic acid in the presence of sulphuric acid, and may also be used as well as their salts to emulsify the above mentioned oily liquids before the latter are added to the ammonium bicarbonate solution. A tar oil before nse may be emulsified by means of ammonia solution. In an example an ammonia solution is saturated with high-grade carbon dioxide while stirring and without cooling. The crystals which separate as the solution cools are removed and dried in a revolving furnace by means of heated air.

Abstract Published.

244,980.—Abietic Acid and Salts.—Dupont, G. H., 29, Rue Marceau Cauderan, Gironde, France.

In a process for the production of pure abietic acid and abietates, the crude acid is

dissolved in a solvent, is transformed into an insoluble salt and is separated from the mother-liquor, as by pressure. In a preferred process, the crude acid is mixed with alcohol, or is formed in alcohol by heating an alcoholic solution of colophony with hydrochloric aid. The mineral acid is then neutralised, and an amount of an alkali such as soda, potash, ammonia or the corresponding carbonates, sufficient to neutralise a fourth part of the abietic acid, is added. Acid salts of abietic acid are precipitated and the whole is subjected to pressure in a hydraulic press to remove the mother-liquor which carries the impurities with it. By action of strong acids on the remaining abietates a pure and nearly colourles abietic acid is obtained.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

UDDOLIN.

465,130.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—B. C. Tipper & Son, Ltd., The Veterinary Chemical Works, 43 and 45, Homer Street, Balsall Heath, Birmingham. February 17th.

PINEATE.

464,784.—Chemical substances prepared for use in medicine and pharmacy.—International Chemical Co., Ltd., 7, Wybert Street, Munster Square, London, N.W.1. February 17th.

ACIDOLAMIN.

457,565.—Chemical substances for use in medicine and pharmacy.—Actien-Gesellschaft fur Anilin Fabrikation, An der Treptower Brucke, Berlin, Germany. February 17th.

BRITISH CHEMICAL ABSTRACTS, Pure and Applied, For Sale, as issued, at half price.—Address Box W.L.44, *Chemical News* Office .

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THE CHEMICAL NEWS,

VOL. CXXXII. No. 3439.

MERTON HOUSE, SALISBURY SQUARE,
LONDON, E.C.4.

TELEPHONES :

Administrative : Central 6521.

Printing Works : Hop 2404.

THE STRUCTURE OF IODINE.

By HAWKSWORTH COLLINS, B.A. (Camb.).

The constitution of iodine has previously been given in the *Chemical News* as Na_4Cl for the following four reasons.—

(1) $4 \times 23 + 35 = 127$.

(2) The third main principle in the constitution and structure of the elements is : Monadic Na (23) takes a prominent part in the formation of all elements of greater atomic weight than itself (*Chem. News*, 1920, CXXI., 157).

(3) Iodine and chlorine are both heptads; and if the valences of the four Na-portions are mutually quiescent as in other cases demonstrated in the *Chemical News*, 1914, CIX., 28, the active portion of iodine is identical with chlorine; and this is the reason why it is always classed with chlorine.

(4) The ultimate matrix of iodine has been traced to sea-weed, in which the element has been and is being formed by the Power of Vegetable Life. The sea-weed is surrounded by a solution of NaCl, the very substance required for the formation of iodine; and $4NaCl = Na_4Cl.Cl_3 = ICl_3$. The last, a well-known componnd, is the first molecule containing iodine to be formed.

The structure of an atom of iodine is therefore as given in No. 5, Table I, taking into consideration the deduced structures for Cl (*Chem. News*, 1914, CIX., 26).

This will now be proved to be correct quite independently by means of the laws of relative volume and heat of formation.

TABLE 1.

THE RELATIVE VOLUMES OF IODINE.

(5)	I	=	Na	+	Na_3	+	Na	+	H	+	H_3	+	H	+	H_3	+	H	+	H_3
(6)	32.77	=	11.85	+	11.85	+	1.54	+	0.97	+	1.54	+	0.97	+	1.54	+	0.97	+	1.54
(7)	27.75	=	11.85	+	11.85	+	1.54	+	0.97	+	1.54	-	0	-	0	-	0	-	0
(8)	25.24	=	11.85	+	11.85	+	1.54	-	0	-	0	-	0	-	0	-	0	-	0
(9)	30.24	=	11.85	+	11.85	+	6.54	-	0	-	0	-	0	-	0	-	0	-	0
(9A)	33.24	=	11.85	+	11.85	+	9.54	-	0	-	0	-	0	-	0	-	0	-	0
(9B)	35.55	=	11.85	+	11.85	+	11.85	-	0	-	0	-	0	-	0	-	0	-	0

The zero-volumes indicate that the helium string has been wholly or partly absorbed by the remainder of the element. Other cases in which the helium-portions disappear in a similar manner were demonstrated in 1924 in the articles on oxygen, sulphur, silicon and phosphorus.

The volume 9.54 for Na was demonstrated in the papers on sulphur, phosphorus and silicon. Also the volume 6.54 for Na was demonstrated in the article on sulphur and will appear later in aluminium and others.

An electro-positive force emanates from each one of the six parts of the three helium-portions, and an electro-negative force from the Na-portion next to them (*Chem. News*, 1919, CXIX., 295).

In No. 6 where the helium-portions are fully extended, these portions must be understood to exist actually as a long string as represented, because the longer the string the greater the volatility (*ceteris parabus*) of the element. The vibrations of this string are similar to those of the tail of a kite, and serve the same purpose. (Vide the *Chem. News*, 1907, XCVI., 176.)

Table II.

Experimental Data Illustrating Table I.

	Relative Volume.	Theor. S.G. at 15°	Obs. S.G.	
(10)	C_2H_5I 48.09 + 32.77	1.930	1.9309	15° Mendelejeff
(11)	*C_3H_7I 48.09 + 16.42 + 32.77*	*1.361*	*1.378*	*0° Thorpe*
			1.301	42° Thorpe
(12)	C_4H_9I 48.09 + 2(16.42) + 32.77	1.619	1.6166	20° Bruhl
(13)	$C_8H_{17}I$ 48.09 + 6(16.42) + 32.77	1.338	1.338	16° Zincke
(14)	KI 22.29 + 32.77	3.016	3.012	20° Spring
			3.059	Playfair
(15)	KI_3 22.29 + 3(32.77)	3.465	3.498	15° Nostrand
(16)	$NH_3.NI_3$ 0.83 + 3(5.76) + 0.83 + 2(32.77)	3.5	3.5	Nostrand
(17)	AgI 10.25 + 32.77	5.44	5.47	0°Deville
			5.35	Schiff
(17A)	NaCl 11.85 + 15.085	2.17	2.17	20° Kaye
(17B)	NaBr 11.85 + 23.09	2.95	2.952	Schiff
(17C)	Ga = Na_3 11.85 = 0 + 11.85 + 0	5.82	5.9	Chem. Kal.
(17D)	$GaCl_3$ 11.85 + 2(23.01) + 15.085	2.406	2.36	80° Nostrand *i.e.*, 2.4 15°
(18)	TlI 19.2 + 27.75	7.05	7.072	15°.5 Twitchell
(19)	BiI_3 21.29 + 3(27.75)	5.644	5.64 – 5.65	20° Gott
(20)	AgI 13.29 + 27.75	5.702	5.707	Damour
(21)	*AsI_3 19.58 + 3(27.75)*	*4.434*	*4.39*	*13° Bodeker*
(22)	SbI_3 21.29 + 3(27.75)	4.786	4.768	22° Cooke
(23)	SbI_3 18.25 + 3(27.75)	4.929	4.848	24° Cooke
			5.01	10° Bodeker
(24)	Ba I_2 23.98 + 2(27.75)	4.91	4.917	Filhol
			4.9	Chem. Kal.
(25)	NaI 11.85 + 27.75	3.79	3.665	25°/4 Nostrand
(26)	CuI 9.54 + 27.75	5.095	5.7	Rodwell
			4.41	Schiff
(27)	I (solid) 25.24	5.032	5.030	Playfair
(28)	ICl_3 30.24 + 3(15.085)	3.1	3.1107	Christomanos
(29)	IF_5 35.55 + 5(5.42)	3.54	3.5	Nostrand
(30)	ICl 35.55 + 15.085	3.209	3.206	18°Hannay
(30A)	I (liq.) 31.74 = $\frac{1}{2}$(30.24 + 33.24)	4.000	4.004	107° Billet

All the above volumes of the several elements have previously been demonstrated in the *Chemical News*, except those of Ga and some of iodine.

In the *Chemical News*, 1924, CXXIX, 107, the following volumes of cobalt were demonstrated :—

Co	=	Al	+	S
11.56	=	4.05	+	7.51
14.56	=	4.05	+	10.51
4.05	=	4.05	+	0

This volume 4.05 splits up as follows :—

Al	=	Na	+	H	+	H_3
4.05	=	1.54	+	0.97	+	1.54

Also the chief volume of titanium, when forming part of an element, has been shown to be 5.02, which splits up as follows :—

$$5.02 = 1.54 + 0.97 + 1.54 + 0.97$$
$$Ti = Na + H + Na + H$$

so that the volume 1.54 for Na is well supported. This value cannot be altered in the slightest without putting a great many facts into confusion; and it is quite distinct from the volume 1.9 for the same element, which has frequently occurred in these papers.

TABLE III.

HEAT OF FORMATION OF IODINE.

								Orig. Vol.		Rel. Vol. in combination 15° C		Change of Volume
(31)	36226	=	120	×	2.377	×	127	30.127	=	27.75	+	2.377
(32)	aq. 37720	=	120	×	2.48	×	127	30.23	=	27.75	+	2.48
(33)	7010	=	120	×	0.46	×	127	33.23	=	32.77	+	0.46
(34)	-51621	=	120	×	(-3.39)	×	127	32.16	=	35.55	-	3.39
(35)	-55021	=	120	×	(-3.61)	×	127	31.94	=	35.55	-	3.61
(36)	-57150	=	120	×	(-3.75)	×	127	31.80	=	35.55	-	3.75

(37) -8568 in a gaseous compound from I (gas)
(38) -11968 in a gaseous compound from I (liquid)
(39) -14097 in a gaseous compound from I (solid)

Nos. 34, 35 and 36 represent the same volume obtained from gaseous, liquid and solid iodine respectively.

Table IV. demonstrates many exact relations between the figures given in Table III.

TABLE IV.

(40) Lat. Ht. of Fusion = 11.71; and 127 × 11.76 = 1494
(41) 37720 - 36226 = 1494
(42) Lat. Ht. of Vap. = 23.97; and 127 × 23.97 = 3044
(43) Specific Heat of Gas = 0.04 (about)
(44) Boiling point, 185°
(45) Melting point, 115°
(46) (185 - 115) × 0.04 × 127 = 356
(47) Specific Heat of solid and liquid = 0.05 (about)
(48) (115 - 15) × 0.05 × 127 = 635
(49) 14097 - 11968 = 2129 = 1494 + 635
(50) 57150 - 55021 = 2129 = 1494 + 635
(51) 11968 - 8568 = 3400 = 3044 + 356
(52) 55021 - 51621 = 2400 = 3044 + 356
(53) 57150 - 51621 = diff. between gas and solid = 5529
(54) 14097 - 8568 = diff. between gas and solid = 5529
(55) Difference in energy content between I (gas) and I (solid) at 19° C., 5450 T.

All the original volumes in Table III. lie between 30.23 and 33.23, except 30.127, which is a volume of solid iodine and does not come into the following matter concerning liquid iodine .

No. 77 contains two forms of iodine, and since they were formed at the same time from the same original substance, this iodine must have contained two different forms of original volumes 30.23 and 33.23. This is confirmed by the only S.G. of liquid iodine available (No. (30A).

No. (80) also contains the two forms but in a different proportion.

The conclusion at which one must arrive from these data is that at 107° C. the two volumes occur in about equal quantities, and that as the temperature increases the proportion of atoms of volume 33.23 increases, and as the temperature decreases the proportion of atoms of volume 30.23 increases. This state of affairs is in exact accordance with all that has gone before; for it is continually being demonstrated that the atom of an element has varying but definite volumes, so that it jumps from one to the other suddenly. (cf. The Quantum Theory.)

It will be noticed that 30.24 and 33.24 are the volumes required in Table I instead of 30.23 and 33.23. This is due to the fact that the figures are ouly taken to two decimal places; for it sometimes depends upon the third decimal place whether the results agree exactly or differ by 0.01, *e.g.*, 30.24 is given in No. (9) as equal to 11.85 + 11.85 + 6.54, each part being correct to two decimal places. But if they were taken to three places of decimals the following might be equally correct, 30.23 = 11.847 + 11.847 + 6.537.

The original volumes 32.16, etc., are mixtures of 30.24 and 33.24 in different proportions.

Table V.

Experimental Data Illustrating Table III.

	Heat of Formation.		Theor.	Obs.	
(56)	Na.I 32706 + 36226	=	68932	69080	Thomsen
	(corresponds with No. 25)				
(57)	Cu.I − 19080 + 36226	=	17146	16260	
	(corresponds with No .26)				
(58)	aq. K. I 37274 + 37720	=	74994	75020	T
(59)	aq. H. I − 24350 + 37720	=	13370	13170	T
(60)	aq. Na. I 32706 + 37720	=	70426	70300	T
(61)	aq. Sr. I_2 67950 + 2(37720)	=	143390	143460	T
(62)	aq. Ca. I_2 73533 + 2(37720)	=	148973	149010	T
(63)	aq. Co.I_2 − 32920 + 2(37720)	=	42520	42520	T
(64)	gas H. I from I (gas) 8005 − 8586	=	−563	−600	T
(65)	gas H. I from I (solid) 8005 − 14097	=	−6092	−6040	T
(66)	gas $C_2.H_5$.I from I (liquid) 22062 − 11968	=	10094	11090 to 9930	T

(This value for C_2H_5 demonstrated by about 50 molecules, was sent to the Nobel Institute in 1923.)

(67)	I. Cl − 51621 + 56786	=	5165	5825	
	(corresponds with No. 30)				
(68)	K. I. O_3 37274 − 51621 + 71515 + 2(32341)	=	121850	124490	
(69)	I. Cl_3 − 51621 + 56786 + 2(7830)	=	20825	21490	T
(70)	aq. H. I. O_3 − 24350 − 55021 + 71515 + 2(32341)	=	56826	55800	
(71)	aq. K. I. O_3 37274 − 55021 + 71515 + 2(32341)	=	118450	117710	
(72)	aq. H_5. I. O_6 − 5(24350) − 57150 + 2(117460) + 4(32341)	=	185384	184400	T
(73)	aq. H. I. O_4 − 24350 − 57150 + 4(32341)	=	47864	47680	T
(74)	I_2. O_5 − 2(57150) + 5(32341)	=	47405	45030	
(75)	S_2. I_2 2(0 + 7010)	=	14020	13600	
(76)	KI. I_2 2(7010)	=	14020	13600	
	(corresponds with No. 15)				
(77)	As. I_3 − 35100 + 36226 + 2(7010)	=	15146	13500	
(78)	P. I_3 − 8593 + 3(7010)	=	12437	10900	
(79)	P_2.I_4 − 8593 − 0 + 4(7010)	=	19447	19800	
(80)	Sb. I_3 − 51621 + 2(36226) + 7010	=	27841	28800	
(81)	Na. I. O_3 32706 − 55021 + 71515 + 2(32341)	=	113882		
(82)	aq. Ba. I_2 72134 + 2(37720)	=	147574	146400	
(83)	aq. Ba. O_2. H_2 72134 + 71515 + 117460 − 2(15300)	=	230509	229260	
(84)	aq. H. Cl. O − 24350 + 23010 + 32341	=	31001	29930	T
(85)	aq. H. Cl − 24350 + 63870	=	39520	39315	T
(86)	aq. Na.O.H 31234 + 96155 − 15300	=	112089	111810	T
(87)	aq. K.O.H 36100 + 96155 − 15300	=	116955	116460	T
(88)	liq. H_2.O − 2(24350) + 117460	=	68760	68360	Thomsen
				69000	Berthelot

All these values of H.F. for the various elements have been demonstrated in former papers except some of those of iodine.

HEAT OF NEUTRALISATION.

When (70) and (86) produce (81) and (88),

31234 becomes 32706
96155 becomes 117460
− 15300 becomes −24350

(89) 32706 − 31234 + 117460 − 96155 −
24350 + 15300 = 13727 13810 T

HEAT OF OXIDATION.

When (59) and (84) produce (70) and (85); *i.e.*, when HI aq. + 3HClO aq. produce HIO_3aq. + 3HCl aq., Thomsen found that 70682 cals. were emitted.

32341 became 71515
3(23010) became 3(63870)
37720 became − 55021

(90) 71515 − 32341 + 3(63870) −
3(23010) − 55021 − 37720 = 69013 70682 T

HEAT OF NEUTRALISATION.

When (70) and (87) produce (71) and (88),

36100 becomes 37274
96155 becomes 117460
−15300 becomes − 24350

(91) 37274 − 36100 + 117460 − 96155
− 24350 + 15300 = 13429 13810 T

HEAT OF REDUCTION.

When (70) and (59) produce free Iodine and (88); *i.e.*, when HIO_3 + 5HI aq. *produce* $3I_2$ + $3H_2O$,

71515 becomes 117460
2(32341) becomes 2(117460)
−55021 becomes 0
5(37720) becomes 0

(92) 117460 − 71515 + 2(117460) −
2(32341) + 55021 − 5(37720) = 82604 83332 T

HEAT OF NEUTRALISATION.

When 59 and 86 produce (60) and (88),

31234 becomes 32706
96155 becomes 117460
− 15300 becomes − 24350

(93) 32706 − 31234 + 117460 −96155 −
24350 + 15300 = 13727 13680 T

HEAT OF ABSORPTION.

When (65) is absorbed by water (88), producing (59),

8005 becomes − 24350
− 14097 becomes 37720

(94) − 24350 − 8005 + 37720 + 14097 = 19462 19210 T

HEAT OF OXIDATION.

When (59) is oxidised, producing (70),

37720 becomes − 55021
0 becomes 71515
2(0) becomes 2(32341)

(95) − 55021 − 37720 + 71515 +
2(32341) = 43456 42630 T

Heat of Solution.

When (56) produces (60),

36226 becomes 37720

(96) 37720 - 36226 = 1494 1220 T

Heat of Neutralisation.

When (59) and (83) produce (82) and (88); *i.e.*, when 2HI aq. + BaO_2H_2 aq. produce BaI_2 aq. + $2H_2O$,

71515 becomes 117460

- 2(15300) becomes - 2(24350)

(97) 117460 - 71515 - 2(24350) + 2(15300) = 27845 27780 T

Summary.

Each one of these 103 experimental data takes its part in the demonstration of the structure of an atom of iodine. If any one of them were to be found to be wrong the others would not be affected in the slightest, so that the whole theory can only be demolished by the gradual extinction of the data one by one.

There is no hypothesis anywhere in the paper. The whole is merely an arrangement of facts in such a manner as to demonstrate the truths which underlie them. Iodine is the twenty-sixth element whose structure has now been demonstrated in a manner uniform with the others, the only difference between the demonstrations being that the later ones are more efficient than the earlier owing to increasing experience in the best method of arranging the facts. The demonstration of the structure of sodium, e.g., in the *Chemical News*, 1924, CXXVIII., 161, could be improved very greatly owing to this increase of experience.

It is impossible to state every reason for any particular result in each paper, and the matter can only be criticised by taking the whole thesis into consideration at the same time.

The following is an example of what is implied by the above statement :—In the *Chemical News*, XCVI., 1907, 176, Sir William Crookes published on the recommendation of Sir William Ramsay the discovery of the Odd and Even Rule, which lies at the foundation of the reasoning and correct deductions which led to the discovery of the structure of each element. If reference were continually being made to all such matters, these papers would become unwieldy and could not be accepted by any scientific periodical.

In addition to the demonstration of the constitution and structure of iodine in this paper by means of the following eight series of experimental data, Atomic Weight, Specific Gravity, Heat of Formation (gas), H.F. (liquid), H.F. (solid), H.F. aq., Specific Heat, and Latent Heat, the following two laws are strengthened—

(I) The law of relative volume;
(II) The law of heat of formation;
(III) It continues the reduction of the experimental data of specific gravity to exact instruments of research.
(IV) It demonstrates the causes of Thomsen's observed experimental results, not necessarily of his calculated results.
(V) It continues the demonstration of the Co-relationship of Physical-Chemical Constants.

The proof that the structure for iodine, which was first published in the *Chemical News* several years ago, is correct, lies in the fact that the relative volumes confirm it exactly, and the values for heat of formation confirm the volumes.

WATER AND METALS UNDER THE INFLUENCE OF ELECTROLYSIS.

By Robert Saxon, B.Sc., F.C.S.

The text book gives the impression that water does not respond to electrolysis, unless " seasoned " with acid or alkali. This seasoning upsets all reasoning with regard to the part played by the water, and to the student makes the decomposition thereof a fake. With a sufficiently high density of current, water will conduct. That got from a plug in the lighting set will furnish enough energy to show a copious shower of gas and convince the pupil that water by itself does dissociate.

The author has worked a series of experiments with various metals used as a *Compound* or *Idle Electrode* that is placed on the insulating floor of an electrolytic cell

between the electrodes. Attention has been drawn in the *Chemical News* (Nov. 20, 1925), to the accelerating solvent influence on acids of the electric current. Weak acids dissolve metals that strong acids would not disturb under ordinary conditions. Most refractory metals oxidise as anodes with weak solutions of oxygen acids. This series attempts to find out to what extent, if any, water acts as an acid.

Water behaves like an acid in a great number of chemical reactions, transferring its hydroxyl group OH to other bases, to displace other anions notably the halogens. It might be called *Hydric Acid*, and its salts hydrates. Towards the alkali and alkaline earth metals it behaves exactly like an acid. The electric current makes it behave so to other metals, whether used as anodes, or in the cell.

Copper placed in the way of the electrolytic flow in the cell gives off a stream of gas which proves to be a mixture of hydrogen with less oxygen than is necessary to form water. Flocculent blue-green hydrate is formed at the same time. No acid whatever is used in these tests. The copper may be looked upon as an extra anode and cathode combined. The action between it and the anode may be represented thus :—

2H)Cu) 2H : 2(OH) (HOH/O
—.—.—.—

Here, in the centre we have water which is not in contact with a charged cathode, but must of necessity in giving up its hydrogen make its side of the copper negatively charged. This is all by virtue of the charge (positive) on the real anode, shown as (to the right of the water.

The action between the copper and the real cathode may be shown as follows :—

2H) 2H : 2(OH) (Cu($Cu(OH)_2$
—.—.—.—

The copper is shown now as an anode (sign (means anode). The water is underlined as a solute, though a liquid, and hydrogen is given off at the cathode, and copper hydrate at the copper. The sign : is used to denote the fact that the two parts of the water are ionised, free to form new associations with any other ions near them if carrying sufficient charge to bring that ion near enough to form molecules not ionised but fast bound.

Magnesium behaves similarly. The floating hydrate is carried up the tube arranged to catch the gases. It is well to push the metal a little way up the tube as it persists in floating if placed in bits on the floor of the cell. The fact that reaction is beginning is shown by the rising of the metal in the water. The metal placed *outside the electrodes*, that is, not between them, gives off gas, though feebly. It would seem that there are *Lines of Electrolytic Force* inside the retaining insulating walls like those round a magnet. Had an acid been added to the water, such would be accused of this action. Why cannot water then be an acid under the same circumstances? It is doubtful if separate chemical reactions go on during electrolysis, as the current dethrones mighty reagents and alters completely their characters. Whatever happens during electrolysis must be completely under its control, though we may not see how that control arranges its sequences.

Zinc behaves like magnesium as well as cadmium, but less vigorously. Mercury gives visible evidence of the " two faced " character of these idle electrodes. That part nearer the anode is bright, whereas that looking towards the cathode darkens with the formation of oxide, possibly suboxide first, but certainly brown oxide later. The mercury is placed as a blob on the floor of the cell, preferably a glass jar with a depression in the centre. The two halves are well marked for some minutes but the oxide gradually spreads even to the reduction area of the cathode. A larger blob would in a good light determine the change of colour in this oxidation.

Bismuth gives the gray oxide on its " anode " side. Tungsten in the form of wire changes quickly in colour from brown to violet and blue, passing rapidly from the dioxide to the trioxide. The range of colours is instructive, especially to students, as the colours rise from brown to blue towards the real cathode. The dioxide does not remain more than a few minutes, as such though clean metal may present itself. This seems to indicate that the dioxide has greater pull upon oxygen than the metal.

CARBON BLACK PRODUCED FROM NATURAL GAS.

By G. B. Richardson.

(*U.S.A .Bureau of Mines.*)

The production of carbon black from natural gas in the United States in 1924, reported to the division of mineral resources of the United States Geologieal Survey prior to its transfer to the Bureau of Mines, by 46 producers operating 69 plants in 9 States, amounted to 186,872,934 pounds—an increase of 35 per cent. over the production in 1923 and nearly three times the output in 1922. Indicated deliveries in 1924 by producers of carbon black amounted to 129,521,602 pounds, contrasted with 102,376,381 pounds in 1923. On December 31 ,1924, stocks of carbon black held in the custody of producers amounted to 95,671,246 pounds, an increase of more than 57,000,000 pounds over the corresponding stocks held on the last day of 1923. This record of overproduction was reflected in the average price per pound received by producers, 6.2 cents, which is the lowest that has been reported since the Government began to compile statistics of carbon black in 1919. The total value at the plants of the carbon black produced in 1924 was $11,564,936.

Louisiana in 1924 not only led all of the States in the production of carbon black, as it has done since 1921, but increased its relative standing by producing 77 per cent. of the total output of the country as contrasted with 73 per cent. in 1923. All of the carbon-black plants in Louisiana obtain their supply of gas from the Monroe field, and for 1924 reports were received covering the operation of 28 plants in Ouachita Parish, 6 in Morehouse, and 1 in Union Parish.

A BIBLIOGRAPHY ON ZINC RETORTS AND CONDENSERS.

By B. M. O'Harra.

(*Formerly Metallurgist, U.S.A. Bureau of Mines.*)

Prefatory Note.

The bibliography here given was compiled as a preliminary step in an investigation of refractory materials for the manufacture of zinc retorts and condensers, and of methods of manufacture, that is being carried on by the Mississippi Valley Station of the U.S. Bureau of Mines, in co-operation with the Missouri School of Mines and Metallurgy at Rolla, Missouri. It is published in the belief that it may be of interest to others who are carrying on similar investigations.

The bibliography has been limited to references on the usual types of horizontal retort and the condensers that are used with them. References to vertical retorts or other types of retort that are not in general industrial use have been omitted. Referenees on refractories or on ceramic engineering in general that have an incidental bearing on the manufacture of zinc retorts and condensers ,although many of them are of prime importance, have also been omitted, as it has been thought best to reserve them for a possible later selected bibliography of such references only.

With these limitations, it is believed that the bibliography covers fairly completely the literature on the subjeet that has been published within the past forty or fifty years. The literature older than that has not been covered so completely ,but such of these old references as have been omitted are at present of little interest other than historical, and the information contained in them has been well summarised in the various standard textbooks on the metallurgy of zinc.—*Published by permission of the Director of thhe U.S. Bureau of Mines. by School of Mines and Metallurgy, University of Missouri.*

General Notes.

THE B.D.H. BOOK OF A.R. STANDARDS.

In 1914 the British Drug Houses undertook the manufacture of analytical reagents according to the specifications of the Special Committee appointed by the Institute of Chemistry and the Society of Public Analysts, and that for the past eleven years they have been supplying regularly not only "A.R." chemicals, hut also a very wide range of chemicals used for what may comprehensively be termed "scientific purposes," including research and teaching.

Some years ago proposals were made to the Council of the Institute of Chemistry that they should re-issue the 'List of Re-

agents for analytical Purposes," prepared in 1914, and that opportunity should be taken to revise some of the monographs, and to add to the number. It was decided, however, that the Institute should not undertake the task.

Feeling that there exists a need for a work of reference of the character outlined, the Company has decided to issue the B.D.H. Book of A.R. Standards for the purpose of defining as exactly as possible the commercially attainable standards for the purity of chemicals used for those scientific purposes for which purity is of great importance. The book contains in all 157 monographs and embraces those 88 substances for which standards were given in the volume published by the Council of the Institute of Chemistry. Additional tests have been made in respect of the substances dealt with in that publication, and in many instances it has been possible to take advantage of much experience gained over an extended period of time to give greater precision to the limits and tests laid down.

The B.D.H. Book of A.R. Standards is published at 2s. 6d., but will be issued at the special price of 1s. 6d. postage 3d. extra, to the users of B.D.H. chemicals.

CANADIAN TRADE WITH THE UNITED KINGDOM AND UNITED STATES.

According to statistics compiled by the Dominion Bureau of Statistics, Ottawa, imports into Canada from the United Kingdom and the United States during 1925 amounted in value to 162,108,180 dollars and 579,746,080 dollars, while exports of Canadian produce to those countries totalled 492,334,687 dollars and 472,274,816 dollars respectively.

BOARD OF TRADE ANNOUNCEMENT.

Dyestuffs (Import Regulation) Act, 1920.

Application for Licences in February, 1926.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during February, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 549, of which 476 were from merchants or importers. To these should be added 18 cases outstanding on January 30, making a total for the month of 567. These were dealt with as follows :—

Granted—475 (of which 458 were dealt with within 7 days of receipt).

Referred to British Makers of similar products—65 (of which 54 were dealt with within 7 days of receipt).

Referred to Reparation Supplies available—7 (all dealt with within 2 days of receipt).

Outstanding on 27th February, 1926—20.

Of the total of 567 applications received 519, or 92 per cent. were dealt with within 7 days of receipt.

ELECTROLYTIC IRON AND TITANIUM PIGMENT.

The High Commissioner for Canada in London has received from the Department of Mines at Ottawa the following article prepared by Mr. W. B. Timm, of the Mines Branch :—

An interesting process which would appear to have commercial possibilities is being developed for the utilisation of Canadian ilmenite ores. By this process, electrolytic iron in the form of tubes and plates is produced from the iron content in the ores, and titanium white, for pigment purposes, from the titanium content. Both these products are somewhat new to the metal and chemical industries. They possess special physical and chemical properties which open up wide fields of application and usefulness.

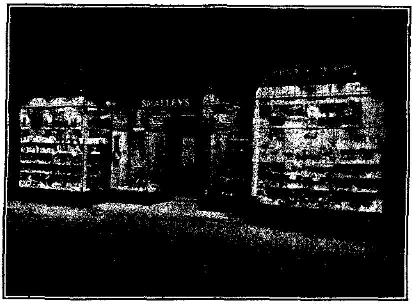
Briefly, the process consists of treating the ilmenite ores with some form of carbon as a reducing agent in a rotary kiln furnace. The iron oxide of the ore is converted to metallic iron in the sponge state and the titanium oxide is left unaltered. The product of the furnace is treated with ferric chloride, the iron dissolved, forming ferrous chloride, leaving an insoluble residue of titanium. The residue is separated from the solution which is electrolysed in a diaphragm cell, iron deposited and ferric chloride formed to be used again, making the process cyclical and continuous.

ILLUMINATING THE DRUGGIST'S WINDOW.

The attached photograph of the premises of Messrs. Smalleys, Chemists and Druggists, of Ipswich, was taken at night solely by the aid of the shop window illumination.

This is proof of the effectiveness of conserving light within the windows, and directing it on the goods displayed, rather than wasting light in the street.

The system adopted is that of GECoRAY reflectors equipped with Osram gasfilled lamps mounted behind a pelmet or valance in each window. Harsh shadows and glare are entirely absent and every detail of these well-dressed windows stands out with the utmost clarity.



INTERNATIONAL COMBUSTION, LIMITED, EXTENDING.

An interesting announcement is to hand from International Combustion Limited, who state that on account of the enormous growth in the demand for its British-manufactured "Lopulco," products, it has become necessary to proceed immediately with an important extension of the works at Derby.

A new foundry section for heavy castings, with core drying ovens, pattern shops and storage, cupolas and complete range of modern handling equipment is to be started at once. The extensions also include an entirely new machine shop ,office extensions and a new shop for the fabricating of sheet metal work, bunkers, cyclones, etc.

Provision has also been made for exteuding the transport system, loading and despatch berths to the new buildings and the total value of the work is estimated at about £100,000.

At the Barrow works, so many orders for Raymond Pulverisers have been received this year that additional machinery is to be installed immediately for dealiug with the manufacture of this equipment.

NEW ARTIFICIAL SILK MILL FOR CANADA.

Canada, which may almost be said to be the home of spruce pulpwood, appears destined to make rapid strides as a producer also of rayon, or artificial silk. With the large plant of Courtauld's, Limited, already in operation, plans are reported of another proposed mill to be located at Drummondville, Quebec. It is said that American and English capital is interested in the new venture, and that it will be known as the Canadian Cellulose and Chemical Company. A total capital of $10,000,000 is involved. The plant will manufacture a product of the cellulose-acetate type.

BRITISH METAL CORPORATION, LIMITED.

The Directors' report for the year ended December 31, 1925, shews the Corporation to be in a flourishing condition :—

The profit for the year, after payment of all expenses and appropriating £50,000 to Reserve Account, as £80,181 14s. 8d.; there was brought forward from last year

£18,265 0s. 5d.; the Directors recommend a dividend of 8 per cent (payable less Income Tax), requiring £78,480; leaving to be carried forward £19,966 15s. 1d.

The business of the Corporation in all its departments was fully maintained during 1925. The Corporation is now directly in touch with all centres essential for its trade in the United Kingdom, and is represented either by its own Branch Offices or by close connections in most parts of the British Empire.

EXAMINATIONS FOR CERTIFICATES AS MINE MANAGERS & SURVEYORS.

Examinations for first and second class certificates of competency as managers and under-managers of mines will be held on May 26 and 27, at Edinburgh, Newcastle-upon-Tyne, Sheffield, Wigan, Cardiff and Birmingham. The written part of an examination for certificates of qualification as surveyors of mines will be held at the same centres on May 27.

Applications for the necessary forms should be made not later than April 6. In order that the appropriate forms may be sent, it is important that candidates should state whether they have already sat at one or more of the Board's examinations. Letters should be addressed to the Secretary, Board for Mining Examinations, Mines Department, Dean Stanley Street, Millbank, London, S.W.1.

INTERESTING ACTION AGAINST CHEMICAL FIRM.

WHAT CONSTITUTES "FLOWERS OF SULPHUR"?

A case of interest to chemical manufacturers and hop growers came before Mr. Justice Horridge at the Surrey Assizes on March 3, when Messrs. Robinson Bros., Ltd., of West Bromwich, were indicted, under the Merchandise Marks Act, for selling goods with a false trade description—namely, as flowers of sulphur what was alleged to be bround sulphur.

Sir Travers Humphreys (for the prosecution) said flowers of sulphur was the name given to sublimated sulphur, which was sulphur treated by being submitted to very high temperatnre, as a result of which it vaporised and was then passed into a cool chamber and condensed. The article was used very extensively by hop growers. The prosecution alleged that defendants had sold as flowers of sulphur ordinary ground sulphur, which was prepared by the simple process of grinding. Mr. Hedley Miller, assistant secretary of the Chamber of Trade, to whom complaint was made, ordered from the defendants 2cwt. of their "Fortress" brand of flowers of sulphur. Upon analysis the substance was found to be ground sulphur.

In reply to the Judge, Sir Arthur Colefax (for the defence) said he was there to have it decided whether flowers of sulphur was the proper description of the article manufactured.

TECHNICAL EVIDENCE.

William Russell Smith, analytical chemist, of Mincing Lane, London, who analysed the sample, said flowers of sulphur under a microscope should be opaque amorphous globules. He was prepared to say that the sample submitted was 98 per cent. pure sulphur. The British Pharmacopœia, when dealing with flowers of sulphur for drugs, limited the amount of acid it contained, and the sample analysed contained no acid. He was using the term flowers of sulphur as synonymous with flowers of sulphur obtained by sublimation. He had no knowledge of any other process than sublimation for making flowers of sulphur.

Reading from the Pharmaceutical Code, Sir Arthur Colefax said sublimated sulphur or flowers of sulphur might be obtained by grinding sulphur.

Witness disagreed with this statement.

Professor H. G. Greenish, joint editor of the British Pharmacopœia, said he did not agree with the statement of the Pharmaceutical Code that flowers of sulphur could be made by grinding down sulphur. He did not know flowers of sulphur could be obtained by any other method than sublimation.

Sir Arthur Colefax said the substance was not sold under a false trade description. The sulphur was manufactured by Messrs. Chance and Hunt, Ltd., and they did not make it by mere grinding. After it was ground it was winnowed by a stream of gas.

Mr. W. Cowburn (Messrs. Cowburn and Cooper, Manchester), Sir W. Alexander M.P. (managing director of Charles

Tennant and Co., Glasgow), and Mr. C. Woolcock (president of the Chemical Industry), gave evidence to the effect that flowers of sulphur could be prepared by other ways than sublimation, and the product had been sold prepared in that way.

On March 4, the jury found for the plaintiff, and Mr. Justice Horridge imposed a penalty of £50, and directed defendants, who wanted the case tested, to pay the costs.

Notice of appeal was given.

THE INSTITUTE OF METALS.

New Articles.

The Institute of Metals has just issued to its members a ballot paper containing the names of 77 candidates for membership, a record list. This is the last occasion upon which a postal ballot for the election of members will be taken. In future election to membership will be by the Council—assuming that the new Articles that have recently been drawn up by the Council are appproved hy the members at the extraordinary general meeting of the Institute to be held on March 11. These Articles were drawn up, we understand, primarily to do away with the postal ballot system, in which there was returned only about ten per cent. of the voting papers issued. Members will still have an opportunity of ohjecting to any membership application as one of the new Articles provides that "the names of the approved applicants shall be placed on a list whicb shall be exhibited in the library of the Institute for at least fifteen days immediately after the Council Meeting at which such names were approved." Copies of the lists are to be supplied to the Secretaries of local sections of the Institute for inspection by Members, and in any other manner to members as may from time to time be prescribed by the Council.

Power is sought by the Council to vary the constitution of the Council. The most important change is that which provides that the Chairman of any local section may be co-opted a member of the Council. The six past presidents who shall be ex-officia members of the Council will be limited to the six most recently retired from the office of president. The election of the Council will continue to be by postal ballot of the members of the Institute.

The first election of Members under the new arrangement is proposed to be held on April 21. Applications for membership should be sent to the Secretary, Mr. G. Shaw Scott, M.Sc., 36, Victoria Street, S.W.1.

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL INSTITUTION.

A General Meeting of the Members of the Royal Institution was held on Monday afternoon, March 1, Sir Edward Pollock, Vice-President, in the chair.

The death was announced of Dr. H. K. Onnes, an Honorary Member of the Institution, and a resolution of condolence with the family was passed.

Miss M. S. Barlow, Dr. W. A. Caspari, Sir James Frazer, Lady Frazer, Mr. R. H. Hayes, Mr. W. Hawthorne, Mr. C. Judson, Miss I. E. Knaggs, Lady Jane Lindsay, Mr. H. H. Macdonald, Mr. P. Nelson, Mr. J. H. Reynolds, Mr. R. Soames, Rev. C. R. Shaw Stewart, Major D. Thompson, and Miss M. Walters, were elected Members.

INSTITUTE OF CHEMISTRY.

The forty-eighth Annual General Meeting of the Institute of Chemistry was held at 30, Russell Square, Professor G. G. Henderson, F.R.S., President, in the chair.

The Meldola Medal was presented to Dr. Henry Phillips.

In moving the adoption of the Annual Report, which showed that the roll of the Institute now numbers nearly 5,000 Fellows and Associates, the President referred to the decrease in unemployment in the profession, and mentioned that there were indications that not only those industries which were strictly chemical in character, but many others, were finding that well trained research and analytical chemists were necessary to combat the effects of industrial depression. To some extent, the situation had been relieved by Members passing into other work and also owing to the fact that the output of chemists from the universities had been less during the last two or three years. The Council, however, were seeking further means to encourage the increased employment of chemists for the benefit of industry and commerce generally.

Reviewing the work of the various committees during the year the President

showed that the standard of qualification and examinations required for membership was well maintained; the regulations for admission were constantly under review in order to meet the demands of an ever-growing science and the ever-changing condition of its application.

The Committee have been concerned with matters affecting fertilisers and feeding stuffs in which valuable assistance had been rendered to the Ministry of Agriculture and Fisheries; with the Royal Commission on National Health Insurance, on which the Council had represented the views of public analysts who are responsible for the examination of drugs under the Sale of Food and Drugs Acts; with the Labour Party, on the subject of Government Scientific Publications; and with the Director of Public Prosecutions, to whom the Council were indebted for valuable advice on the question of fees allowed to professional chemists in forensic matters.

The Local Sections of the Institute had become increasingly active, and the character of the papers read and the discussions held emphasised the ever-growing enthusiasm for the welfare and advancement of the profession. There was talk of seeking statutory powers of registration for professional, consulting and analytical chemists; and that matter was under the consideration of the Council because the Institute was the recognised and duly authorised body to carry out any such registration. It was its business to provide a hall-mark for those who might rightly be considered as competent and to maintain a register of such, and these duties were carried out by the Council with every regard to the grave responsibility which was entrusted to them.

The annual accounts were passed, and the Officers and Council for the ensuing year were elected, as follows :—

President—Prof. G. G. Henderson, D.Sc., F.R.S.

Vice-Presidents—Prof. E. C. C. Baly, C.B.E., F.R.S.; Mr. E. R. Bolton; Mr. A. Chaston Chapman, F.R.S.; Dr. Harold G. Colman; Dr. T. Slater Price, O.B.E., F.R.S; Mr. E. W. Voelcker ,A.R.S.M.

Hon. Trqasurer—Mr. Patrick H. Kirkaldy.

General Members of Council—Mr. F. W. F. Aranud, Mr. H. C. L. Bloxham, Mr. Arthur, J. Chapman, Dr. G. C. Clayton, C.B.E., M.P., Prof. J. W. Cobb, C.B.E., B.Sc., Dr. W. M. Cumming, Prof. J. C. Drummond, D.Sc., Dr. Bernard Dyer, Mr. A. Vincent Elsden, B.Sc., Mr. A. G. Francis, B.Sc., Prof. Thomas Gray, D.Sc., Dr. R. H. Greaves ,M.B.E., Prof. I. M. Heilbron, D.S.O., D.Sc., Mr. Edward Hinks, M.B.E., B.Sc., Mr. A. W. Knapp, B.Sc., Prof. W. H. Lewis, M.A., Mr. Thomas Macara, Mr. B. G. McLellan, Dr. R. S. Morrell, M.A., Prof. F. L. Pyman, D.Sc., F.R.S., Mr. L .G. Radcliffe, M.Sc., Dr. Eric K Rideal, M.B.E., Mr. William Rintoul, O.B.E., Mr. F. Scholefield, M.Sc., Dr. Arthur Slator, Prof. J. F. Thorpe, C.B.E., F.R.S., Dr. J. F. Tocher.

The following District Members of Council also take office on 1st March, 1926.

Birmingham and Midlands—Mr. C. A. F. Hastilow, M.Sc.

Bristol and South-Western Counties—Mr. Frank Southerden, B.Sc.

Liverpool and North-West Coast—Mr. H. J. Evans, B.Sc.

London and South-Eastern Counties—Mr. E. M. Hawkins.

Manchester and District—Mr. S. E. Melling.

North-East Coast and Yorkshire—Dr. L. G. Paul.

Edinburgh and East of Scotland—Dr. Leonard Dobbin.

Glasgow and West of Scotland—Mr. W. H. Coleman.

Wales and the County of Monmouthshire—Mr. C. A. Seyler, B.Sc.

Northern Ireland—Mr. J. H. Totton, B.A., B.Sc.

Irish Free State—Dr. W. R. Fearon, M.A.

The Overseas Dominions, The Empire of India, and Abroad—Dr. Frankland Dent.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The Directional Recording of Atmospherics. By R. A. WATSON WATT, B.Sc. (Eng.), Associate Member. Communicated by permission of the Radio Research Board.

The paper describes a simple pen-writing instrument for the continuous recording of the apparent direction of arrival of atmospherice, and cites typical samples of the data obtainable from such recorders. The samples chosen show the diurnal variation of intensity of atmospheric disturbance, the diuranl variation of apparent direction of arrival, and the location of apparent

sources of atmospherics by a group of recorders.

The data which have until recently been available as to the incidence of atmospherics have consisted almost entirely of relatively brief and isolated observations based on aural estimates. There does not yet exist a sufficient quantity of comparable data, from well-spaced observing stations, over an adequate period, to present anything beyond the barest outline of the world distribution of atmospherics. The purpose of the present paper is to describe an instrument which, despite many limitations and imperfections to be enumerated, does enable continuous records taken under comparable conditions at widely distributed stations to be obtained and compared without an excessive expenditure of effort. The description is followed by the presentation of some data from a first group of such recorders, which is presented as typical of the minimal results to be expected from an international network of co-ordinated recording stations. Such a network seems to be called for at the present stage of research on atmospherics.

The development of the recorder to be described arose from a limited investigation into the possibility of locating thunderstorms by observations on the apparent direction of arrival of atmospherics, which was initiated by the Meterological Office in 1915. This work was subsequently developed into a fundamental inquiry into the origin and nature of atmospherics, under the auspices of the Radio Research Board which was established under the Department of Scientific and Industrial Research in 1920.

A survey of the published data on atmospherics has impressed on the author's mind the complete inadequacy of sampling represented by these data, the diversity and absence of specification of the variables at the receiver, and the immense loss of value resulting from the non-co-ordination of the observations. The present paper has been planued to offer a description of an instrument which is certainly not the best that can now be designed, but which has proved itself capable of providing consistent data at a minimum cost. The nature of the data has been indicated by samples of three aspects; it is hoped that means may soon be found for placing at the disposal of those interested the whole of the data obtained.

The instrument has already been made the basis of series of observations at stations widely distributed in the eastern hemisphere, but the network is of far too open a mesh at present. It is suggested that the time has now arrived for the organisation of an international scheme, which need not absorb much labour or capital, for the collection of data on the lines indicated. The author is glad to be allowed to say that a second step in such a scheme is being taken, by the installation of two recorders, of the pattern described, at German meteorological observatories.

The facilities for carrying out the work described were provided, and permission to communicate this paper was granted, by the Department of Scientific and Industrial Research, on the advice of the Radio Research Board established under that Department. Thanks are due to the Board, under the chairmanship of Sir Henry Jackson, R.N., G.C.B., K.C.V.O., F.R.S., Member, and its Committee on atmospherics, under the chairmanship of Col. H. G. Lyons, F.R.S., for their interest and advice. Thanks are also due to the staff of the Radio Research Statiou, Mr. J. F. Herd, Associate Member, Mr. J. E. Airey, and Mr. F. E. Lutkin, and to a former member of staff, Mr. W. S. Hay, for their enthusiastic and skilful assistance in the design, construction and maintenauce of the recorders and the reduction of the records, to Mr. J. Hollingworth, M.A., B.Sc., of the National Physical Laboratory, Associate Member, assisted by Mr. H. A. Thomas, M.Sc., for the calibration, to the Air Ministry for the installation and maintenance of the recorders at Lerwick and Aboukir, and to Prof. J. K. Catterson-Smith, Member, for similar collaboration at the Indian Institute of Science, Bangalore.

FORTHCOMING EVENTS

THE ROYAL SOCIETY.

Thursday, March 18, at 4.30 p.m.

ROYAL SOCIETY OF ARTS.

Monday, March 15, at 8 p.m. (Cantor Lecture.) W. F. Higgins, M.Sc., National Physical Laboratory, "Thermometry." (Lecture I.)

Wednesday, March 17, 8 p.m. (Ordinary Meeting). Lieut.-Col. John Herbert Boraston, C.B., C.B.E., "Co-Partnership." Viscount Cecil of Chelwood, P.C., K.C., will preside.

SOCIETY OF GLASS TECHNOLOGY.

A meeting of the Society of Glass Technology will be held at Talbot Hotel, Stourbridge, on Wednesday, March 17, 1926.

A special request is made to members to make this meeting a success. The Stourbridge glassmaking district is one which, since its products are hand-made, has felt keenly the stress of foreign competition. Members' presence at the meeting will do something to show their interest in the welfare of the industry in this neighbourhood.

ROYAL INSTITUTION OF GREAT BRITAIN.

Friday, March 12, Sir J. J. Thompson, O.M., LL.D., D.Sc., F.R.S., M.R.I., Master of Trinity. "Radiation from Electric Discharges."

Friday, March 19. John Tweed, sculptor.

Tuesdays, March 16 and 23, at 5.15 p.m. "The Growth of Crystals." By Cecil H. Desch, D.Sc., F.R.S., Professor, Metallurgy, University of Sheffield.

MINERALOGICAL SOCIETY.

Tuesday, March 16, at 5.30. A. H. Hallimond, "Molecular Volume Relations in the Mica Group." E. D. Mountain, "Smithsonite from the Rhodesia Broken Hill Mines." E. D. Mountain, "The Identity of the Cobija and Lampa Meteoric Stones."

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

464,657.—Device bearing word CYANOGAS for an Insecticide and Rodent exterminator (chemical).—American Cyanide Co., 511, Fifth Aveuue, New York City ,New York, U.S.A. February 24th.

SPECIFENE.

465,509.—Chemical substances prepared for use in medicine and pharmacy.—Higgolene, Ltd., 137, Upper Bond Street, Hinckley, Leicestershire. February 24th.

LAXAMINT.

466,440.—Chemical substances prepared for use in medicine and pharmacy.—International Chemical Co., Ltd., 7, Wybert Street, Munster Square, London, N.W.1. February 24th.

BRITISH CHEMICAL ABSTRACTS, Pure and Applied, For Sale, as issued, at half price.—Address Box W.L.44, *Chemical News* Office .

SUBSCRIPTION TO "THE CHEMICAL NEWS."

Subscriptions, generally, expire at the year end, and we would thank subscribers who have not yet renewed their subscriptions to do so at their early convenience. Those who send their subscription through agents should give the latter instructions.

Owing to the large number of Postal Subscribers in all civilised countries, it is impracticable to communicate with each one individually. To avoid unnecessary expense and correspondence, subscriptions should accompany new or renewal order.

Cheques, etc., should be made payable to "The Chemical News, Ltd., crossed "a/c payee only," and sent to the Chemical News, Ltd., Merton House, Salisbury Square, London, E.C.4. (England).

BINDING CASES.

Handsome Red Cloth (stiff) Binding Cases, Gold-lettered, for Binding the *Chemical News*, can now be had from the Office, Merton House, Salisbury Square, London, E.C.4. Price 3/-; post free, 3/3; or two Cases in one parcel, post free 6/-.

"THE CHEMICAL NEWS."

The *Chemical News* is on sale after 12 noon every Thursday, and can be ordered through Railway bookstalls or any newsagent of standing, price 6d. per copy. It can also be sent by post to any part of the world, price 30/- per year, from the Publishing Offices, Merton House, Salisbury Square, London, E.C.4. (England).

Publisher's Announcements.

The following Books can be obtained from Rea and Inchbould, Merton House, Salisbury Square, London, E.C.4.

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THE CHEMICAL NEWS,

VOL. CXXXII. No. 3440.

MERTON HOUSE, SALISBURY SQUARE,
LONDON, E.C.4.

TELEPHONES :
Administrative : Central 6521.
Printing Works : Hop 2404.

RING CHAIN TAUTOMERISM, PART II.—THE OCCURRENCE OF TAUTOMERISM OF THE THREE CARBON TYPE BETWEEN A HOMOCYCLIC COMPOUND AND ITS UNSATURATED ISOMERIDE.

By R. F. HUNTER, M.Sc., D.I.C., B.Sc., A.R.C.S.

It was pointed out, it will be recalled, by Ingold and Perren (*J.C.S.*, 1921, CXIX., 1582) and Ingold and Powell (*J.C.S.*, 1921, CXIX, 1976) that the condensation usually termed the Michael reaction between α β unsaturated esters and compounds such as ethyl cyanoacetate which contain the reactive hydrogen atom is a reversible process, the condensation product undergoing fission into its components under the conditions of formation. In general, therefore, the result is a balanced action, for any particular set of conditions the ultimate product is an equilibrium mixture, the composition of which is the same no matter whether the starting material is the condensation product or a mixture of the two esters which have to be condensed to give this condensation product.

The proof of the reversibility of this reaction is of interest because it completes the analogy with three carbon tautomerism. For example the equilibrium which we have indicated and which we will term the equilibrium (A) is strictly comparable with the equilibrium, the existence of which is clearly proved, if further proof is necessary by the recent researches of Feist and his collaborators (*Annalen*, 1922, CCCCXXVIII 25, 40, 59 and 68) between the labile glutaconic esters, which we may term the equilibrium (B). Both reactions are reversible but the reaction (A) is intermolecular whilst the reaction (B) is intramolecular, this would appear to be the whole formal differeuce between them. It is precisely this difference, however, which renders the second reaction alone capable of being brought within the philosophical definition of tautomerism as reversible change between isomerides.

From this point of view, then, the glutaconic acid change is an intramolecular Michael condensation. Clearly, however, it is but one of a large number of theoretically possible intramolecular changes of which the reaction (A) that is the reversible Michael reaction is the intermolecular prototype for the two carbon atoms which become joined by a single bond in the reaction (A) and by the double bond in the corresponding change expressed in the change (B) might one may suppose become involved in a cyclopropane or cyclobutane ring or in larger rings as a result of intramolecular condensation. Since this internal condensation would be of the same nature as a Michael reaction we should expect it to be reversible.

CR : CY.CO_2Et
|
(: Cn).C[H]X.CO_2Et
↑ ↓
CR – CY[H] CO_2Et
|
(: Cn) – CX.CO_2Et (C)

It is obvious that the case (B) is the case where n = O. The unsaturated open chain compound (I) and the saturated cyclic compound (II) are isomerides and the equation (C) must therefore be regarded as expressing a kind of tautomerism, and clearly moreover, tbe relationship represented belongs to the group of phenomena to which the name ring chain tautomerism has been applied (*loc. cit.*). All the examples of ring chain tautomerism hitherto discussed in this journal have been of the keto-enol type the simplest of which is the example of Deshapande and Thorpe on the occurrence of ring chain tautomerism in the gem diethyl series (*J.C.S.*, 1922, CXXI., 1430).

Keto enol tautomerism may be formulated in general terms as follows :

(: Cn).C[H]XCO_2Et
|
CR = O
↑ ↓
CR – O[H]
| \
(: Cn) – CXCO_2Et (D)

and there is ample evidence at the present time of its occurence.

Equations (C) and (D) are precisely similar, and the former is therefore to be regarded not only as the general expression for an internal Michael condensation, but also on broader lines, as the fundamental formula for three carbon ring chain tautomerism. From what has been written with regards the relationship of three carbon carbon ring chain tautomerism to the ordinary direct and retrograde Michael reaction (A), to the tautomerism of the glutaconic esters (B) and the keto-enol ring chain tautomerism (D) there seems every reason to believe in the possibility of both the occurrence and reversibility of the reactions expressed in equation (C), and indeed in the reality of the general phenomenon which this equation represents.

It will be recalled that at an early period Guthzeit found that ethyl α carboxyglutaconate (III) on keeping at the ordinary temperature for a year or on treating with a small amount of piperidine for a much shorter period became transformed into a liquid bimeric ester to which the formula (IV) was assigned (*Berichte*, 1898, XXXI., 2753; *J. pr. Chem.* 1909, (ii) LXXX., 435).

$$(CO_2Et)_2CH.CH : CH.CO_2Et$$
(III)

$$\begin{array}{l} (CO_2Et)_2.CH.CH\text{—}CH.CO_2Et \\ \qquad\qquad\quad | \qquad | \\ \qquad CO_2Et.CH\text{—}CHCH(CO_2Et)_2 \end{array}$$
(IV)

Ethyl dicarboxyglutaconate (V) appeared to undergo a similar change, but more slowly. In this case, however, the condensation product represented by formula (VI) was a solid, melting at 103°, from which a stereoisomeride melting at 87° could be obtained. In the absence of piperidine, the conversion was appreciable after one year, whilst when piperidine was added the change proceeded to the extent of 75 to 80 per cent. in seven weeks (*J. pr. Chem.*, 1909 (ii) LXXX, 412) and (*Berichte*, 1901, XXXIV., 675).

$$(CO_2Et)_2CH.CH : C(CO_2Et)_2$$
(V)

$$\begin{array}{l} (CO_2Et)_2CH.CH\text{—}C(CO_2Et)_2 \\ \qquad\qquad\qquad | \qquad | \\ \qquad (CO_2Et)_2C\text{——}CHCH(CO_2Et)_2 \end{array}$$
(VI)

More recently Verkade showed (*K. Akad. Wetensch. Amsterdam*, 1919, XXVII, 1133), that α cyanoglutaconic ester (VII) undergoes conversion with great ease in the absence of piperidine into a substance to which by analogy is given the formula (VIII).

$$CO_2EtCH(CN)CH : CHCO_2Et$$
(VII)

$$\begin{array}{l} CO_2Et.CH(CN).CH\text{—}CH.CO_2Et \\ \qquad\qquad\qquad\quad | \qquad | \\ \qquad CO_2EtCH\text{—}CH.CH(CN)CO_2Et \end{array}$$
(VIII)

In none of these cases has any inquiry been made into the cause or mechanism of the changes observed previous to the work of Ingold, Perren and Thorpe (*J.C.S.*, 1922., CXXI., 1765). The term "polymerism" seems to have been considered sufficiently *self-explanatory*, and no attempts had been made to show why some glutaconic esters "polymerise" and others do not, or why the rapidity and completeness of the process vary in the way they do in different instances. Neither had any one previously endeavoured to demonstrate the ordered solidarity of the reactions under discussion with any large and well worked out group of phenomena.

The fundamental circumstance is that a glutaconic ester contains within its molecule both the residues by the interaction of which a Michael condensation can take place. For instance, α carboxyglutaconic ester contains a malonic ester residue and an acrylic ester residue, if the reaction between these is intramolecular, three carbon tautomerism in the sense of (B) is the result, but if the malonic ester residue of one molecule reacts with the acrylic ester residue of another molecule, the product (IX) is a substance capable of exhibiting ring chain three carbon tautomerism (Equation C) with its cyclic isomeride (X)

$$\begin{array}{ll} (CO_2Et)_2C[H].CH : CHCO_2Et & \rightarrow \\ CO_2Et.CH : CH.CH(CO_2Et)_2 & \leftarrow \end{array}$$

$$\begin{array}{ll} \qquad (CO_2Et)_2C.CH : CH.CO_2Et & \rightarrow \\ \qquad\qquad\qquad | & \\ CO_2EtCH[H]CH.C[H](CO_2Et)_2 & \leftarrow \end{array}$$
(IX)

$$\begin{array}{l} \qquad (CO_2Et)_2C\text{——}CHCH[H]CO_2Et \\ \qquad\qquad\qquad | \qquad | \\ CO_2EtCH[H]CH\text{—}C(CO_2Et)_2 \end{array}$$
(X)

The last reaction is an internal Michael condensation and the evidence for its reversibility has been established by Ingold and his collaborators (*J.C.S.*, 1922, CXXI., 1775, 1776, 1785 and 1786). However, it can be definitely stated that the experiments of Ingold, Perren and Thorpe (*ibid.*, 1765), prove conclusively that the above view of the mechanism of the reaction is a true one. It is necessary, therefore, to revise the formula (IV) of Guthzeit, Weiss and Schafer for the so-called "bimeride" of α carboxyglutaconic ester.

Formula (VI) stands correct, but the formation of the substance from ethyl dicarboxyglutaconate must be preceded by the production of an open chain isomeride.

To Verkade's compound must be given the formula (XI), the intermediate product being the unsaturated ester (XII).

$$CO_2EtC(CN)CH : CHCO_2Et$$

$$CO_2EtCH_2CH.CH(CN)CO_2Et$$
(XII)

$$\begin{array}{c} CO_2EtC(CN)CHCH_2CO_2Et \\ | \\ CO_2EtCH_2CH — C(CN)CO_2Et \end{array}$$
(XI)

The action of piperidine in promoting these condensations is easily understood. As Knoevenagel and Mottek first showed (*Berichte*, 1904, XXXVII., 4464), piperidine is a powerful catalyst for the Michael condensation and in many cases can be used with advantage in place of the sodium ethoxide commonly employed. Its behaviour in the cases under discussion is well illustrated by the condensation recently described by Ingold and Perren (*J.C.S.*, 1922, CXXI., 1414) of ethyl dicarboxyglutaconate with ethyl cyanoacetate. This condensation takes place with ease in the presence of piperidine and there can be no question but that the effect of the piperidine on the reaction between two molecules of dicarboxyglutaconic ester is of precisely similar character.

It appeared at first sight that one of the main theoretical difficulties in connection with the study of these condensations would be the interpretation of the apparently fortuitous way in which tendency towards self condensation is linked with structure. The facts are as follows—Glutaconic ester itself (XIII) does not undergo self condensation, neither does α methylglutaconic ester (XIV) nor the labile form of β methylglutaconic ester (XV) α carboxyglutaconic etser (III) however condenses with facility, yet β carboxyglutaconic ester shows no tendency to condense. Neither α cyano β methylglutaconic ester (XVI) nor α cyano β methyl γ ethylglutaconic ester (XVII) undergoes self condensation, but α cyano γ methylglutaconic ester condenses easily.

$$CO_2EtCH_2.CH : CHCO_2Et$$
(XIII)

$$CO_2EtCHMeCH : CHCO_2Et$$
(XIV)

$$CO_2EtCH_2CMe : CHCO_2Et$$
(XV)

$$CO_2EtCH(CN)CMe : CHCO_2Et$$
(XVI)

$$CO_2EtCH(CN)CMe : CEtCO_2Et$$
(XVII)

nevertheless, α cyano γ ethylglutaconic ester shows no tendency to condense. Although both α carboxyglutaconic ester and α cyano γ methylglutaconic ester undergo self condensation with ease, α carboxy γ methylglutaconic ester shows no tendency to do so, the α carboxy γ ethyl derivative shares this property but the $\alpha\gamma$ dicarboxy compound (IV) condenses with ease. Ethyl α cyanoglutaconate condenses so rapidly that it is almost impossible to isolate it, its γ methyl derivative also condenses, its γ ethyl derivative does not, its γ phenyl derivative shows a very slight tendency towards self condensation.

In considering these facts it is necessary to take into account the conditions which govern the occurrence of any Michael reaction. These have been broadly indicated by Ingold and his collaborators in their work on the synthesis of the polyacetic acids of methane, and on which an article has been communicated to this Journal. The main points are as follows :—

(A)—The acetic ester which takes part in a condensation must contain a negative substituent such as a carbethoxy or cyano group to confer the necessary mobility on the adjacent hydrogen atom, the cyano group is by far the most effective.

(B)—The acrylic ester involved should be only lightly substituted

(i) The presence of a β substituent, particularly two β substituents considerably reduces the tendency towards condensation. The effect appears to be a spatial one, the larger are the groups the stronger is the inhibition.

(ii) The presence of an α substituent greatly inhibits condensation, the magnitude of the effect depending on the size of the group under (i).

(iii) The simple spatial relationships noted (i) and (ii) break down in the case of strongly electronegative substituents such as the carbethoxy and cyano groups which inhibit condensation perceptibly but very slightly. It is necessary to postulate here some kind of polar effect superimposed on, or in some way modifying the cimple spatial phenomenon.

By the application of these principles to the cases under discussion, we obtain in the first place a complete account of the behaviour of all the glutaconic esters which have been examined with regard to their capacity for self condensation. The rules are sufficiently definite, moreover, to enable one to predict the susceptibilities of those glutaconic esters which have not as yet been examined in this connection.

According to the rule (A) it is a necessary condition for self condensation that the portion of the glutaconic ester molecule which may be regarded as its acetic ester residue should contain a negative substituent such as the carbethoxy or the cyano group, that is to say, one or other of these groups must be present in the α position. In agreement with this inference we find that every one of the glutaconic esters which have been shown to undergo self condensation contains an α carbethoxy group or an α cyano group, no glutaconic ester which lacks a negative α substituent of this sort has ever been shown to undergo this type of change. According to rule (A) α cyano glutaconic esters should undergo condensation more readily than the corresponding α carbethoxy compounds. Actually ethyl α cyanoglutaconate passes into its condensation product in minutes in the absence of a catalyst and instantaneously in the presence of piperidine, whilst ethyl α carbethoxyglutaconate changes in the course of months in the absence of a catalyst and in a few days in the presence of piperidine.

A β substituted glutaconic ester is to be regarded as a $\beta\beta$ disubstituted acrylic ester, and should, according to rule (B) (i) show but little tendency to condense, even if the conditions required by rule (A) are fulfilled. As a matter of fact, all the β substituted glutaconic esters which have as yet been examined have failed to exhibit any tendency towards self condensation.

A γ substituted glutaconic ester may be regarded as an α substituted acrylic ester and according to rule (B) (ii), condensation should be inhibited by the presence in this position of groups of considerable atomic volume. In agreement with this conclusion we find that if the α substituent required by rule (A) is a carbethoxy group, any gamma alkyl group, even the methyl group, is sufficient to prevent condensation; if, however, the alpha substituent is the more strongly reaction-promoting cyano group, then not only the γ hydrogen compound, but also the γ methyl compound, gives condensation products, although γ alkyl groups larger than methyl inhibit the reaction. Finally, the behaviour of compounds containing a carbethoxy or a cyano group in the β or γ position should, by the rule (B) (iii) be generally similar to that of the corresponding substance, which has a hydrogen atom in place of this group. The similarity of behavious of ethyl α carboxyglutaconate and ethyl $\alpha\gamma$ dicarboxyglutaconate forms an instance of the application of this rule, but it should be added that glutaconic esters of the type in question have not as yet been extensively examined.

These rules and facts can be conveniently tabulated as follows :—

(A) Glutaconic esters without a negative α substituent do not condense :

The esters

$CO_2Et.CH_2.CH : CH.CO_2Et$
$CO_2Et.CHMe.CH : CH.CO_2Et$
$CO_2Et.CH_2CMe : CHCO_2Et$
$CO_2EtCH_2.C(CO_2Et) : CH.CO_2Et$

do not condense.

(B) Glutaconic esters without a β substituent do not condense :

The esters

$CO_2Et.CH(CN)CMe : CH.CO_2Et$
$CO_2Et.CH(CN)CMe : CEt.CO_2Et$

do not condense.

(C) Glutaconic esters (outside the classes (A) and (B)) with a γ substituent condense if it is sufficiently small :

(i) α Carboxyglutaconic esters—
The ester $(COOEt)_2CH.CH : CH.COOEt$ condenses.

The esters
$CO_2Et)_2CHCH : CMeCO_2Et$
$(CO_2Et)_2CHCH : CEtCO_2Et$
do not condense.

(ii) γ Cyanoglutaconic esters—
The esters
$CO_2EtCH(CN)CH : CHCO_2Et$
$CO_2EtCH(CN)CH : CMeCO_2Et$
condense.

The esters
$CO_2EtCH(CN)CH : CEtCO_2Et$
$CO_2EtCH(CN)CH : CPhCO_2Et$
do not condense.

(D) Glutaconic esters with strongly negative β or γ substituents behave similarly to the corresponding β or γ hydrogen compounds.

The ester $(COOEt)_2CH.CH : C(COOEt)_2$ condenses.

Thus, is appears that all the facts relating to the self condensation of the glutaconic esters are in complete and detailed agreement with the general principles which have been reached in other ways. It is evident that examples of the type of self condensation under discussion will always be comparatively scarce because so many conditions have to be satisfied.

Now the work of Ingold and his collaborators (*J.C.S.*, 1922, CXXI., 1414), clearly proved that the equilibria attained in Michael condensations between esters were often of an entirely different order from the equilibria between corresponding sodio derivatives. That this must be so follows from the considerations relating to the heats of formation of the sodium compounds (*ibid.*). It is the case, it will be recalled, in the formation of the substituted methanetriacetic ester unobtainable by condensation in the presence of sodium ethoxide owing to the adverse character of the equilibrium between the sodium compounds. The equilibrium between the esters themselves, however, is much more favourable to the formation of the condensation product, which may readily be prepared in the presence of piperidine as catalyst. The relationship appears to be general, for it does not appear possible to obtain any trisubstituted methanetriacetic ester of the type we have referred to by the condensation of sodium derivatives which might be expected to lead to the methanetriacetic derivative owing to the large tendency towards fission into simpler esters, which, however, may condense in the presence of piperidine to give considerable quantities of the methanetriacetic ester, the general conclusion being then that the condensation which takes place in the presence of piperidine is reversed by sodium ethoxide. Now all the compounds (IX) etc., which constitute the first products of the self condensation of the glutaconic esters are methanetriacetic esters similar to the one under discussion and it is therefore to be expected that these substances will be formed from glutaconic esters in the presence of piperidine and decomposed into glutaconic esters in the presence of sodium ethoxide. The research of Ingold, Perren and Thorpe showed this to be the case. Thus the ester which is formed in considerable amonnt from ethyl dicarboxyglutaconate with the aid of piperidine and can be isolated in moderately pure form is converted almost completely into ethyl dicarboxyglutaconate by sodium ethoxide.

There is every reason to believe that similar phenomena appear in the cyclic series and that, for example, methanetriacetic esters of the type (XVIII) exhibit analogous relationships

$$CH \begin{cases} CXCO_2Et \\ \quad >CRR^1 \\ CV.CO_2Et \\ CHZ.CO_2Et \end{cases} \quad \underset{\text{Sod. Etroxide}}{\overset{\text{Piperidine}}{\rightleftarrows}}$$

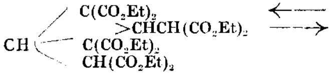
(XVIII)

$$CH \begin{cases} CX.CO_2Et \\ \quad CRR^1CHVCO_2Et \\ CZCO_2Et \end{cases}$$

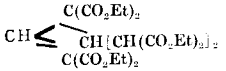
(XIX)

It is clear that all the cyclobutane esters with which Ingold, Perren and Thorpe dealt are metanetriacetic esters of the type (XVIII) whilst their open chain isomerides (IX) etc., belong to the type (XIX) and therefore it is to be expected that the ester (VI), for example, would show the following relations with the product obtained by

the condensation of ethyl dicarboxyglutaconate in the presence of piperidine (XX).



(VI)



(XX)

The degradation effected by sodium ethoxide is therefore progressive and there can be no difficulty in understanding the fact that all the cyclobutane esters dealt with in Ingold, Perren and Thorpe's paper are completely disrupted by sodium ethoxide into the glutaconic esters from which they were originally prepared.

It has been shown that the succession of intermolecular and intramolecular Michael condensations by means of which the cyclobutane esters are formed can be completely reversed by changing the experimental conditions. It remains now to examine the evidence for the existence of a definite equilibrium under any one particular set of conditions. Let us consider the pair of isomerides (VI) and (XX). The cyclobutane ester (VI) is a solid, melting at 103°, whilst the open chain ester (XX) is a liquid, so that when crystallisation of the solid ester has once commenced, the equilibrium in the liquid phase becomes continuously disturbed until the whole of the material is converted into the solid isomeride. By employing a solvent, however, or by allowing interconversion to proceed at somewhat above the ordinary temperature, it is easy to show that an equilibrium is reached containing upwards of 80 per cent. of the cyclic compound and 10 to 20 per cent. of its open chain isomeride, which can be separated from the mixture in the manner described by Ingold, Perren and Thorpe (*J.C.S.*, 1922, CXXI., 1785, 1786). The equilibrium is substantially the same, whether piperidine is present or not, and it is also the same whether the starting material is the cyclobutane ester or the open chain ester or any mixture of them.

It is clear, therefore, that these esters satisfy all the requirements of what we have termed the philosophical definition of a tautomeric substance, and there is no distinction to be drawn from this point of view between the cyclobutane ester (VI) and Knorr's ketonic ethyl acetoacetate. Both esters in the fused or dissolved state undergo reversible isomeric change and reach equilibria dependent only on the temperature and solvent. In both cases the reaction, although hastened by the deliberate addition of a catalyst takes place at a more or less considerable speed without this aid. In both cases, also, the mechanism of the change is extremely simple, involving nothing more than the transmigration of a mobile hydrogen atom. Finally, in both cases the pure liquid esters exhibit the phenomenon, so that there can be no question of a composite reaction, involving for example the addition and subsequent removal of water. This example, then, seems to give us a clear case of reversible interconversion between liquid substances, the one an open chain compound, and the other a cyclic compound, by the simple transmigration of a mobile hydrogen atom.

It remains to be added that just as the ketonic and enolic forms of ethyl acetoacetate each exhibt their own distinctive chemical reactions, corresponding with their respective structural formulæ, so the two indiivduals of the ring chain system each display all the special characteristics expressed by the formulæ assigned to them. The open chain compound (XX), for instance, is highly unsaturated and on mineral acid hydrolysis yields an acid the constitution of which is clearly proved by the manner of its oxidation. On treatment with cold alkaline permanganate, it takes up four atoms of oxygen and is converted almost quantitatively into methanetriacetic acid and oxalic acid, one carboxyl group being eliminated as carbon dioxide subsequently to fission at the double bond. On the other hand, the cyclic compound (VI) is fully saturated and resists the action of permanganate. On hydrolysis with mineral acide, it yields a saturated acid of the cyclobutane series. This acid, 2 : 4 dicarboxycyclobutane 1 :3 diacetic acid was obtained by Ingold, Perren and Thorpe in all five of the theoretically possible stereoisomerides.

Highbury New Park,
N.5.

General Notes.

LONDON CHEMISTS FINED.

Mr. Horace Bland and Mr. D. C. Jones, trading as Curtis and Co., chemists, High Holborn, London, were each ordered to pay a fine of £7 and £1 1s. costs by Sir Chartres Biron, at Bow Street Police Court on 10th instant, for selling calomel ointment containing only 12 per cent., instead of 20 per cent. of calomel. Mr. Glyn Jones, for the defendants, said the firm were summoned at that Court three months ago on precisely the same state of facts. In the present case, Mr. Stephens, the manager, served the food and drugs inspector who ordered the sample and, while mixing the ointment, remarked to him, " It's all right this time. I have made it myself." He was afterwards dumbfounded to find that the proportions were the same as in the case of the previous prosecution. The magistrate remarked that there had been considerable carelessness.

THE PEAT FUEL INDUSTRY IN CANADA.

The Natural Resources Intelligence Branch of the Department of the Interior at Ottawa, has prepared a specially illustrated article on the Peat Fuel Industry of Canada, a copy of which has been forwarded to the Natural Resources and Industrial Information Bureau at the Canadian Building, Trafalgar Square, S.W.1., for the information of parties interested.

ORDER FROM JAPAN.

We are informed that Osaka Shosen Kaisha, (Osaka Mercantile Steamship Co., Ltd.), have ordered two vessels of 1.500 tons gross register, to be constructed by Messrs. Mitsubishi Zosen Kaisha, at their Kobe Shipyard, each of which will be equipped with two sets of Vickers 600 H.P. Diesel engines.

SIR ERNEST RUTHERFORD ON RARE GASES.

Lecturing at the Royal Institution, Albemarle Street, London, on 6th instant, on " Rare Gases of the Atmosphere," Sir Ernest Rutherford exhibited a small piece of grey stone, which was, he said, perhaps 500,000,000 years old, and which contained embedded in it, helium. The discovery, he said, of a group of rare gases in the atmosphere—namely, helium, krypton, argon, neon, and xenen, had markedly influeneed the advance of science in certain directions, and given us information of great value on the structure of atoms.

This advance, he declared, due to the work of the late Lord Rayleigh and Sir William Ramsay, was a great triumph for English science. Some of these gases are now produced on a large scale, having found numerous industrial applications. It was probable that 100,000,000 litres of argon were produced annually throughout the world , mostly for use in gas-filled electric lights. Neon is now produced in considerable quantity, mainly for discharge tubes used in illuminated advertisements. Helium in snfficient quantities to fill an airship was obtained from natural gases both in Canada and the United States.

It had opened up a new region of research where the properties of matter could be examined at such a low temperature that the movements of the atoms and molecules had almost ceased. The flying atoms of helium liberated from radium by its spontaneous disintegration had proved an invaluable aid in determining the structure of atoms.

IMPENDING NEW LEGISLATURE AS TO FERTILISERS.

At the meeting of the Royal Agricultural Society of England on March 3, the question of fertilisers (among other matters) was considered. The Consulting Chemist's report dealt with the fineness of grinding of basic slag and mineral phosphates.

The necessity for paying attention to the fineness of grinding of certain phosphatic materials, in order that they may become available for the plant's use, is emphasised by the following instances which have recently occurred :—

(*a*) *Basic Slag*—

A member of the Society, resident in Shropshire, purchased ,at 60s. per ton, a delivery of basic slag under a guarantee of its containing 34 per cent. of phosphate. On analysis of a sample, this was found to give only 30.74 per cent. of phosphate, and to have only 56.72 per cent. of " fine meal." On complaining to the vendors, an allowance of 12s. per ton was made.

(*b*) *Fossil Phosphate*—

In this case, also occurring in Shropshire, 10 tons had been purchased at £4 10s. per ton delivered. Analysis of a sample showed it to contain 61.51 per cent. of phosphate, but it was coarsely ground, giving only 60.8 per cent. of "fine meal," instead of 80 per cent., or so, which it should have done. A guarantee of 56 per cent. of phosphates had been given, but none of the fineness.

(*c*) *North African Phosphate*—

A member of the Society, resident in Essex, sent me a sample of this, purchased at 65s. per ton delivered, under a guarantee of 60 per cent. of phosphate, but without any guarantee of the fineness of grinding. The analysis showed 58.64 per cent. of phosphate, but only 57.4 per cent. of fineness. Unfortunately, the material had all been drilled before the result of analysis came to hand.

The Committee recommended that enquiry be made of the Ministry of Agriculture as to what steps were being taken with regard to the introduction of a Bill to amend the Fertilisers and Feeding Stuffs Act.

Lord Bledisloe said that, as he stated in the House of Lords on the previous day, it was proposed to introduce the Fertilisers and Feeding Stuffs Bill in the House of Lords soon after Easter.

INSTITUTION OF FUEL TECHNOLOGY.

ORGANISING COMMITTEE APPOINTED.

Sir William Larke, K.B.E.
Sir Richard Redmayne,
Sir Philip Dawson, M.P.
Admiral Sir E. J. W. Slade.
Edgar Evans.
David Brownlie.
S. McEwen.
Sydney North.
Dr. W. M. Travers, F.R.S.
Professor R. V. Wheeler.
W. M. Selvey.
Dr. R. Lessing.
Leonard Harvey.
David Wilson.
Percy Hambly.

With several others in addition who have not yet definitely accepted.

(*See Chairman's Inaugural Speech on this Page.*)

PROPOSED INSTITUTION OF FUEL TECHNOLOGY.

OPENING STATEMENT BY SIR WILLIAM J. LARKE, K.B.E., (CHAIRMAN), AT THE INAUGURAL MEETING ON MARCH 5.

"Before passing to the consideration of the agenda in detail, it is perhaps desirable that I should state briefly the genesis of the movement which has produced such a widely representative meeting.

When the proposal was first made to a few people interested in fuel that an organisation should be created for the promotion and the efficient utilisation of fuel and the co-ordination of work in connection therewith, a preliminary enqury was instituted among those personally known to the original propounders of the suggestion as being interested in fuel; such an enquiry could not and was not intended to be comprehensive but purely exploratory in character. The response to that enquiry was of such a character as to indicate a widespread interest in the proposal to form a national organisation for the consideration of fuel problems, and was of such a character and magnitude that a further and wider enquiry was rendered necessary, of which this meeting is the result.

This enquiry was also naturally limited in character and necessarily failed to reach large numbers of those who will be interested in the proposal and who conld lend the weight of great authority and reputation to this movement. To these I am requested to say that it is hoped they will appreciate, as all things must have a beginning, that any omission to advise them was the natural result of the limitations imposed by lack of time and facilities.

The result of this wider but still limited enquiry is that about 400 replies have been received giving unqualified support to the proposal for the formation of such an organisation, and 40 have expressed either dissent or neutrality with regard to the proposal. Those supporting the proposal represent various aspects of work in connection with fuel research, production and utilisation covering a very wide range of fuel interests in science and industry.

From the Agenda it will be obvious that it is only possible to outline the broad consderations which it is suggested should govern the discussion of these proposals; that the organisation should be national in character and so comprehensive as to be

representative of all those interested in fuel in any form or application.

Fuel practice and problems in widely divergent industries have frequently so much that is fundamentally common that an organisation designed to provide a means of co-ordinating experience and results must be to the national advantage and contributory to the general improvement of industrial efficiency.

In this connection, it is proper that I should mention that I understand informally the governing body of the Institute of Fuel Economy Engineers as individuals, are prepared to support a national movement of this character ,and it is hoped that if the proposal to form a national organisation is adopted, that it will be fully represented on any Organising Committee that may be elected. It will then be for that Committee to consider ways and means for arriving at such an arrangement as will result in complete unanimity of effort under a single organisation.

The Organising Committee, if such be appointed, will, no doubt, ensure in any such scheme which they may propound for final adoption, such bye-laws as will secure all the various interests in fuel shall be proportionately represented on the governing body.

Possibly the Iron and Steel Institute may serve as a model, as widely embracing in its membership all those interested in its objects, it has succeeded in obtaining a status and authority of the highest order.

Although such a large number of those who have been approached have given unqualified support to the proposal, there is—as must be expected—an influential body of opinion which considers that the movement may be premature, and that it is undesirable to form an additional Technical Institute in view of the number which already exist. The answer to the first objection is, I think, to be found in the large body of support which the proposal has spontaneously secured.

With regard to the second, that it is undesirable to form another technical institution, most of us will have a measure of sympathy with this criticism, but it seems reasonable to point out in this connection that although there are a number of other scientific institutions with great traditions and reputations which may, from time to time, from their own particular point of view, discuss fuel problems, there is no organisation which collates the information in relation to fuel research and its practical application to industry, and therefore there is no means of making available to all the experience obtained in the various fields of work.

It has been suggested in the course of personal discussion on this proposal that the field could be covered, or the objects could be met by the formation of a fuel group in existing Institutions. The difficulty, however, is that the membership of any existing Institution is necesarily identified with particular lines of work, and the Fuel Group therein would not cover the whole field effectively ,even if it could do so as regards the actual work itself it could not have the wide appeal for membership which a separate Fuel Organisation would be likely to exercise.

If this proposal finds acceptance among a snfficient body of opinion to enable it to proceed, I feel confident that those entrusted with the work of organisation will ensure that the new body promotes the interests with which it is entrusted by the fullest collaboration with existing Institutions and avoids any possbility of overlapping of interests or work.

There is certain to be complete unanimity of aim in a desire to secure that the widespread interest expressed in fuel problems shall be organised in such a manner as to secure the most efficient application of the results of scientific research to the benefit of industry; any divergence of view will be limited to the best method of attaining this result, and it will, doubtless, be part of the duties of the Organising Committee, if appointed, to meet as far as practicable, any criticisms that may be raised so that the critics of to-day may become the supporters of to-morrow.

My own position in the Chair may require a word of explanation, as I make no claims to a detailed knowledge of fuel technology, but the whole of my life as an engineer, I have been connected with the use of fuel, particularly in power generation, and I am associated with an industry in which fuel represents some 35 per cent. of its total production costs. I am, therefore, personally deeply concerned with a dispassionate and disinterested consideration of this proposal, which, if it is goverened by national, as distinct from sectional, considerations, should, I am confident, be a very important factor

in improving our national industrial efficiency.

In discussing the resolutions that will be moved I would ask speakers to be good enough in view of the ground to be covered to keep strictly to the matter of the resolution to which they are speaking and to develop to the fullest extent the points they wish to make.

(*Vide Organising Committee on Page* 188.)

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read at the meeting held on Thursday, February 25, 1926:—

(I) The Relativity Theory of Plane Waves. (II) Electronic Orbits on the Relativity Theory. By O. R. BALDWIN AND G. B. JEFFERY. Communicated by Prof. L. N. G. Filon, F.R.S.

(1) It has been shown by Weyl that *gravitational waves of small amplitude may* be reoslved into waves of three types—longitudinal-longitudinal (L-L) longitudinal-transverse (L-T), and transverse-transverse (T-T). Eddington showed that the only physically real waves are T-T waves, and identified a particular type of T-T wave, accompanied by an electromagnetic wave, with ligbt. It appeared, however, from his solution that these waves are not purely periodic, but are accompanied by a cumulative change, which seems to indicate that plane light waves cannot be propagated indefinitely.

In the present paper, waves of *finite* amplitude are discussed without approximation. It is shown that, whether accompanied by electro-magnetic waves or not, L-L and L-T waves are fictitious, while T-T waves propagated with the velocity of light are physically real. The exact differential equation of light waves is obtained and various forms of solution discussed. It appears, however, that Eddington's conclusion that plane light waves cannot be propagated without a cumulative change is confirmed by the more exact treatment.

(2) For an electron and nucleus attracting according to the law of the inverse square of the distance, either the one can describe about the other a circular orbit of any radius, or, if on the balance there is a mutual repulsion, no circular orbits are possible. On the relativity theory the inverse square law is no longer accurately obeyed, and the circumstances under which a circular orbit can be described are less simple. For example, for certain ratios of changes of masses, the radius (r) of the orbit must satisfy inequalities of the type $a<r<b$ or $r>c$. The restrictions on r are given for all possible values of the masses and changes of the electron and nucleus.

The Motion of Two Spheres in a Viscous Fluid. By MARGARET STIMSON AND G. B. JEFFERY. Communicated by L. N. G. Filon, F.R.S.

If a viscous fluid is in steady motion symmetrical about an axis, the stream function satisfies the equation $\phi^2(\psi) = 0$, where ϕ denotes the differential operator

$$\omega\frac{\delta}{\delta\omega}\left(\frac{1}{\omega}\frac{\delta}{\delta\omega}\right)+\frac{\delta^2}{\delta z^2}$$

ω, z being cylindrical co-ordinates. The *solution of this equation is* $\psi_1 + z\psi_2$, where ψ_1 and ψ_2 are any solutions of $\phi(\psi) = 0$.

The solution of this equation is bipolar co-ordinates is employed to determine the stream function of the motion generated by two spheres moving with equal velocities in their line of centres. The fluid thrust on each of the spheres is calculated and numerical values are computed for the case of equal spheres.

Evidence for a Film Theory of Hydrogen Overpotential from Surface Tension Measurements. A. L. MCAULAY AND F. P. BOWDEN. Communicated by Prof. F. G. Donnan, F.R.S.

In order that hydrogen may be liberated at the cathode a film of high-surface tension must first be formed over the mercury. In a pure acid electrolyte the passage of extremely small quantities of electricity produce this film, which remains intact when the circuit passing the current is broken.

Addition to acid of small quantities of ions of metals more noble than copper *destroys the film completely and instantly.* The following gave this result: Ag, Hg, Au, Pt, Ir. The addition to the acid of ions of metals less noble than copper leaves the film intact. The following gave this result: Na, Zn, Cd, Fe, Co, Sn, Pb, Sb. The effect

of Cu is intermediate between these cases. Thus it seems that *the film when fully formed has a definite place in the electrochemical series.*

Production of overpotential at the cathode requires the initial establishment of the film. Conditions that will *not* produce overpotential, when a film has not first been formed over the cathode, produce overpotential when a film has previously been formed over it.

Relation between Single Electrode Potential and Surface Tension.—The film can be built up slowly by the passage of extremely small currents. Till a certain stage is reached single electrode potential measured above reversible potential of mercury is proportional to surface tension of film. Further addition to the film increases single electrode potential but leaves surface tension approximately constant.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

The Search for Oil in Australia. By ARTHUR WADE, D.Sc., A.R.C.S., F.G.S., M.Inst.M.M., F.Am,G.S. (Member).

On March 9, Mr. Wade read a very interesting paper on the largely unrewarded search made for oil in Australia. He gives details of the efforts of various searchers, pointing out the great boon which a native supply would be in times of peace, and more so in times of war, to the white population of the Commonwealth. He concludes :—

" On broad lines of geological history, some authorities on petroleum have come to the conclusion that supplies of oil are not likely to be found in Australia. For example, White and Schuchert have stated that Australia is ' not especially rich in marine deposits, and when these are present they have been subjected to mountain making to such an extent that all the volatile hydro-carbons have long since vanished into the air or been transformed into fixed carbon.' They also state that Australia is a continental nucleus or ' shield,' and therefore has hardly at any time been under the sea. Now it is dangerous to generalise thus for a continent, and errors or part errors are included in this statement. While it may be true in a general way to say that Australia is not especially rich in marine deposits there are areas in which such deposits are of considerable importance and thickness. Moreover, in such cases, any evidence that these beds have been much subjected to mountain making is conspicuous only by its absence.

E. C. Andrews, head of the Geological Survey Department of New South Wales, on the other hand, draws attention to the absence of marked folding in the Post-Palaeozic sediments and refers to the lack of alteration in sediments from Cambrian times. At the same time he lays stress on the general absence of such evidences of the existence of petroleum as would attract the notice of the old time prospectors who did such excellent pioneering work in other directions. He also notes that most of the important oilfields of the world are situated in the Geo-Synclinec paralleling the curves, arcs, or zones of great mountain building folds, and that such conditions do not exist in Australia. On these grounds he is not optimistic as to the chances of finding oil in Australia, but thinks that if commercial pools do exist they will be found in formations older than the Tertiary. This is, I think, a reasonable opinion based on first hand and practical knowledge of the geological conditions existing in Australia.

On the other hand, a number of authorities at the request of the Government of Queensland gave opinions based on the discovery of large volumes of wet natural gas at Roma and the geological conditions as revealed by the logs of the bores at that place. Most of the writers were optimistic as to the chances of finding oil in this part of Queensland, and favoured the continuation of the work of prespecting and drilling.

Thus, there is some conflict of opinion. Opinions based on broad generalisations are on the whole unfavourable. Those based on conditions existing in particular areas are inclined to be favourable. This is perhaps what might be expected from the nature of the Australian Continent. Very large areas are distinctly unfavourable for the occurrence of petroleum, but the close study of a few areas of comparatively limited extent leads one to the conclusion that commercial pools of oil do occur elsewhere in association with conditions which are not unlike those which exist in these places, and that such factors as may militate against possible accumulations of oil

in these areas are not the absence of normal necessary conditions for formation, accumulation and preservation, but the presence of abnormal factors which operate locally and are not usually active in productive oilfield areas. Australia, however, cannot afford to leave the matter in doubt. The need for internal supplies of oil is pressing, and those areas which are most favourable by reason of the nature of the sedimentary accumulations and geological structures will be tested in the only satisfactory manner that is available to us, that is by drilling."

THE OPTICAL SOCIETY.

At a meeting of the Optical Society held at the Imperial College of Science, South Kensington, on Thursday, 25th February, 1926, the following papers were presented and discussed :

Notes on the Significance and Detection of Low Errors of Refraction. By O. Aves.

Examination of a great number of records of tests on the eye for the purpose of prescribing spectacles reveals a large proportion of low errors of refraction. The author suggests certain modifications of the usual technique that, in his opinion, should be incorporated when testing such cases. The usual objective methods of sight examination prior to a subjective test are practically useless in the estimation of errors under one dipptre. A close preliminary objective examination produces distinct after-images on and around the macular area, which perceptibly interfere with vision. In the subjective test the lenses should be added binocularly, before testing the eyes separately. The blocking of one eye tends to induce strain, while relaxation of accommodation is much easier when both eyes are being used. Change of lenses during a test should be made smoothly without allowing the eyes to be uncovered by a lens or be covered by two lenses. Other points calling for attention in the testing of small errors are the strength of the spherical and cylindrical lens elements, the direction of the axis of the cylinder, refinement of the test for muscular correction and the possibility of the presence of irregular astigmatism.

Vertex Power and its Measurement. By W. H. A. Fincham.

The demand for increased accuracy in the determination of refractive errors has emphasised the need for accurate specification and measurement of the powers of correcting lenses. The effect of an ophthalmic lens may be expressed in a number of different ways. The following quantities are used in relation to it :(1) equivalent or true power; (2) vertex power or vertex refraction, *i.e.*, the power at the vertex nearer the eye; (3) neutralising power; usually the front vertex power, (4) thin lens power, *i.e.*, the sum of the powers of the two surfaces, thickness being neglected. In the case of ophthalmic lenses vertex power is the important quantity as it gives the effective value of the lens at some definite and easily determined point on the lens and consequently lenses of any form having the same vertex power are interchangeable if the vertex of each lens occupies the same position with respect to the eye. An instrument designed for the measurement of vertex power is described and the results of measurements on a number of lenses are given.

COURTAULD INSTITUTE OF BIO-CHEMISTRY.

In 1924, Mr. S. A. Courtauld (chairman of the artificial silk company), gave a sum of £20,000 to Middlesex (London) Hospital to endow a Chair of Anatomy. He has now presented to the same Hospital a sum of £30,000 for research purposes in connection with medical school. It is to be known as "The Courtauld Institute of Biochemistry."

ALLEGED ISOLATION OF ELEMENT OF ATOMIC NUMBER 61.

It was announced on 8th instant by the University of Illinois that Dr. B. S. Hopkins, Professor of Inorganic Chemistry, claims with his assistants, to have isolated from rare earths one of the five elements whose places in the scale of atomic members had not, up to the present, been filled. Its place is the 61st in the scale. The discovery is the result of more than five years of elaborate researches with specially constructed X-ray machinery.

CORRESPONDENCE.

A SERIOUS EXPLOSION WITH POTASSIUM.

(*To the Editor of* THE CHEMICAL NEWS.)

Sir,—We were the witnesses of an extraordinary and serious accident in the course of an ordinary demonstration on the properties of the alkali metals, that we think it our duty to inform the scientific public through the medium of your Journal.

Mr. H. Russell Ellis, Headmaster of this school, was demonstrating to a matriculation class the interaction of sodium and potassium with water. He had successfully shown the usual experiments with sodium, and turned to the bottle containing potassium in the form of balls. Remarking on its appearance, Mr. Ellis proceeded to remove a piece by means of a pen-knife, as he had previously done with the sodium. On inserting the knife into the potassium, a violent explosion took place, shattering the bottle to minute fragments, and igniting the naphtha which covered the potassium. Mr. Ellis's face was seriously burned and injured by the ignited potassium, and his hands were severely lacerated by the glass, thus adding to his agonies.

He was conveyed to hospital, and afterwards to his home, where his condition remained serious, if not critical, for some days. Glass was found twenty-four feet from the seat of the explosion.

Every precaution had been taken by the experimenter, who is well known as a skilful practical chemist. We are unable to account for the occurrence of the explosion other than that the potassium—which was many years old—was contaminated with potassium carbonyl, a known explosive impurity in the metal prepared by the old process of distilling a mixture of potassium carbonate and carbon.

Our object in making known this unfortunate accident is to warn science lecturers and others of the danger attending the use of potassium.

J. GERALD F. DRUCE,
EDWARD J. WEEKS.

Battersea Grammar School,
St. John's Hill, S.W.11.
8 March, 1926.

A RETROSPECT.

Mr. C. T. Kingzett, F.I.C., who is well-known in chemical circles, has written a most interesting little pamphlet of 24 pages entitled "A Retrospect," in which he reviews his life work in respect of chemical and industrial science. His recent contributions to chemical literature as well as his "Chemical Encyclopædia" (1923), are fresh in the minds of chemists, but the wide volume of his earlier work is not so generally known.

The Chemical News, and other journals, from the early '70's onwards, have contained many important papers from Mr. Kingzett, and it is not without interest to note that the first occasion upon which he ventured into print was in September, 1871, when, in the form of a letter to *The Chemical News*, he rescutitated Prout's hypothesis of the "One-ness of Matter," with some distinctions, a subject to which he has returned from time to time, dealing with the evolution of the chemical elements and the subject of transmutation.

He firmly repudiates the existence of the physicists' æther and is critical of modern views respecting the constitution of electrons, isotopes, heat and light.

Much of his earlier work was done jointly with Thudichum and dealt with animal chemistry, in particular ,that of the brain substance.

In investigating the aerial oxidation of certain essential oils, he was led to the discovery of the sanitary products now manufactured by the "Sanitas" Company, of which he was for many years the managing director, and is still chairman. He has made many contributions to inorganic and organic chemistry, chemical industry, hygiene and other borderline subjects.

It may be recalled that he was the first to isolate approximately pure calcium hypochlorite from bleaching powder, to give a chemical formula to the alkaloid, Pilocarpine, and to clear up much that was doubtful respecting the production of zinc hy various processes. He also took an active part in the movement that led to the formation of the Institute of Chemistry, and was the first to suggest that of a Chemistry House—a subject which has received a good deal of attention in recent years, but which has not yet materialised, although some steps forward have been made.

Mr. Kingzett is the author of a number of books, several of which are recognised as the standard works in the branches they treat, and it is particularly interesting to learn from the " Retrospect " that he continues to be engaged upon additions to his *Chemical Encyclopædia*, referred to above, especially on the industrial side, with the view of making it as complete as such a comprehensive work can be in these progressive days, against the time that a new (fourth) edition is called for.

NOTICES OF BOOKS.

A Dictionary of Applied Chemistry. By SIR EDWARD THORPE, C.B., LL.D., F.R.S. Vol. VI. S. Acid Tetryl. 780 pp., with many illustrations. Well bound. Price £3 net. London : Longmans, Green and Co., 39, aternoster Row, E.C.4.

The long list of scientific men of standing who figure as contributors to this work, is certainly a guarantee of accuracy, and gives an indication of completeness. While there are many new articles, the whole work has been carefully revised and brought up to date where necessary, sections having been entirely re-written. Fine chemicals have received special attention, and considerable additions have been made to many subjects of technical importance. A high-class reference book.

The Chemists' Year Book, 1926. 1180 pp., and copious Index. Edited by F. W. Atack, M.Sc., D.Sc., etc. Price, 21s. Sherratt and Hughes, Cross Street, Manchester.

This work is well-known in the chemical world, and deservedly so, for it is comprehensive, reliable, and the various subjects and sections well arranged. There is included in the present issue a new section on lubricants, by H. Moore, M.Sc.Tech., and the American methods included in the section on Agricultural Chemistry have been revised by an expert. It is a very useful reference book. It is round-cornered, and strongly bound, and is a handy size for the pocket.

FORTHCOMING EVENTS

ROYAL SOCIETY.

Thursday, March 25, at 4.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.

21, Albemarle Street, London.

Saturdays, March 20, 27, at 3 p.m. " The Rare Gases of the Atmosphere and their Importance in Atomic Theory." By Sir Ernest Rutherford, O.M., LL.D., D.Sc., F.R.S., M.R.I., Prof. of Natural Philosophy, R.I., and Cavendish Prof. of Experimental Physics, University of Cambridge.

Tuesday, March 23, at 5.15 p.m. " The Growth of Crystals," by Prof. C. H. Desch.

Thursday, March 25, at 5.15 p.m. " The Indecisiveness of Modern Warfare," by Prof. J. Holland Rose.

Friday, March 26, at 9 p.m. " The Radiation from Atomic Nuclei," by Sir E. Rutherford.

ROYAL SOCIETY OF ARTS.

John Street, Adelphi.

Friday, March 19, at 4.30 p.m. (Indian Section.) Lady Chatterjee, O.B.E., M.A., D.Sc., " Women and Children in Indian Industries." The Viscountess Chelmsford, G.B.E., will preside.

Monday, March 22, at 8 p.m. (Cantor Lecture.) W. F. Higgins, M.Sc., National Physical Laboratory, " Thermometry." (Lecture II.)

Wednesday, March 24, at 4.30 p.m. (Ordinary Meeting.) Sir Frank Baines, C.V.O., C.B.E., Director of Works, H.M. Office of Works, " The Preservation of Folk Architecture in this Country."

GEOLOGICAL SOCIETY OF LONDON.

At the Meeting on Wednesday, March 24, Sir T. W. Edgeworth David will deliver a lecture on the Physiography and Tectonic Structure of the Commonwealth of Australia.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

4,680.—American Cellulose and Chemical Manufacturing Co., Ltd.—Treat-

ment of solutions of fatty acids. February 18th.

4,305.—Chemische Fabrik auf Actien vorm. Schering, E.—Manufacture of organic auto-mercapto acids and salts thereof. February 15th.

4,698.—Coley, H. E.—Manufacture of sulphides. February 18th.

4,525.—Dewar, W.—Treatment of tin ores, etc. February 17th.

4,525.—Etablissements Metallurgiques de la Gironde.—Production of aluminium alloys. February 17th.

4,319.—Freudenberg, H.—Manufacture of alkali metal cyanides. February 15th.

Specifications Published.

236,891.—Naugatuck Chemical Co.—Manufacture of polymerized products from styrol and its homologues.

247,050.—Badische Anilin & Soda Fabrik.—Purification of gases.

247,052.—Badische Anilin & Soda Fabrik.—Manufacture and production of colouring-matter pastes.

241,579.—Farbenfabriken Vorm. F. Bayer & Co.—Manufacture of alkali salts of aromatic sulpho-chloramides.

Abstract Published.

245,287.—Dyes; dyeing. — Farbwerke vorm. Meister, Lucius, & Bruning; Hoechst-on-Main, Germany.

Disazo dyes; azo dyes, forming on the material.—Azo dyes are produced, in substance or on the fibre, by coupling diazotized benzaldehydeazo-α-naphthlyamines with 2 : 3-oxynaphthoic arylides. The dyeings on the fibre are chiefly black, reddish-black, and greenish-black, and their fastness may be improved, by treatment with a copper salt. The dyestuffs may be converted into water soluble compounds by treatment with bisulphite. The diazo components are obtained by coupling diazotised aminobenzaldehydes with α-naphthlyamine or its derivatives coupling in the 4-position. According to examples a dyestuff is produced in substance from *m*-benzaldehydeazo-α-naphthlyamine and 2 : 3-oxynaphthoic-β-naphthylamide, and cotton is dyed by impregnating with 2 : 3-oxynaphthoic-α- or β-naphthlyamide and developing with diazotized *m*- or *p*-benzaldehydeazo-α-naphthylamine.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

SALABROSE.

465,526.—Chemical substances prepared for use in medicine and pharmacy.—Chemische Werk Grenzach Aktiengesellschaft, Friedrichstrasse 110 to 112, Berlin, N.24., Germany. February 24th.

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Publisher's Announcements.

The following Books can be obtained from Rea and Inchbould, Merton House, Salisbury Square, London, E.C.4.

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All communications should be addressed to the Manager, CHEMICAL NEWS.

THE CHEMICAL NEWS,

VOL. CXXXII. No. 3441.

Merton House, Salisbury Square,
London, E.C.4.

Telephones :

Administrative : Central 6521.

Printing Works : Hop 2404.

A COMPACT AND COMPREHENSIVE SERIES OF REACTIONS AND TABLES IN CHEMISTRY.

A NEW NOTATION IN CHEMISTRY.

By Robert Saxon, B.Sc., F.C.S.

Solids, Liquids, and Gases.

Water exists in three forms, ice, water, and steam. These may be represented respectively by the formulæ $\underline{\text{HOH}}$, $\underset{-\,-\,-}{\text{H O H}}$, and $\underset{\cdots}{\text{HOH}}$. To represent the fact that we heat ice to its melting point, and afterwards to its boiling point to form water and steam, the facts are stated thus :—

$$\underline{\text{HOH}}\ \overset{\text{—}}{_{\text{mp}}}\ \underset{-\,-\,-}{\text{H O H}},$$

$$\underset{-\,-\,-}{\text{H O H}}\ \overset{\text{—}}{_{\text{bp}}}\ \underset{\cdots}{\text{HOH}}.$$

Thus the chemical composition does not change, but the form of the compound does, for the steam contains energy stored up which the ice had not, and is capable of bringing about chemical changes when brought into contact with other bodies which ice could not. Steam is not ice chemically any more than acetylene is benzene. It is not correct, therefore, to say that HOH (ice) equals HOH (water) equals HOH (steam). Such a statement only means that the weights of the three are the same. We indicate the form of a compound by underlining. If we wish to give the temperature necessary to bring about a change in form or composition, we place such in the position occupied by mp or bp thus :

$$\underline{\text{HOH}}\ \overline{\text{0d}}\ \underset{-\,-\,-}{\text{H O H}}\ \text{100d}\ \underset{\cdots}{\text{HOH}}.$$

We prefer to call these expressions Sequences and not equations. We take a line or dash to say " changes into," and to take the place of the sign of equality in chemical equations, and where there is no chance of error in interpretation, we write it thus /. Under it if horizontal, or to the right of it if oblique, we indicate the nature or measure of energy necessary to start the reaction. Thus, adopting the oblique form of the " magic wand," we can state the amount of energy necessary to melt 18 grams of ice to 18 grams of water as 1.4 big cals, thus :—

$$\underline{\text{HOH}}\ /\ 1.4\ \underset{-\,-\,-}{\text{H O H}}$$

$\underline{1}.4$ means in in our notation 1.4 big cals, or the heat necesary to raise 1,000 ccs. of water through 1.4 degrees Centigrade.

The amount of heat necessary to boil 18 grams of water would raise the temperature of 1,000 ccs. of water through 9.7 degrees Centigrade. This fact can be expressed thus :—

$$\underset{-\,-\,-}{\text{H O H}}\ /\underline{9}.7\ \underset{\cdots}{\text{HOH}}.$$

Thus, when we wish to say that we are dealing with Big Calories, say, n of them, we underline the unit digit, or place an underlined capital C after the number. We will do so in both ways. The latent heat of fusion of water is -1.4 Big Calories, expressed thus :—

$$\text{HOH}\ \underline{\text{Cm}}\ \underline{-}1.4\ \text{ or }\ \text{HOH}\ \underline{\text{Cm}}\ -1.4\ \underline{\text{C}}.$$

The quantity is negative because so much energy has to be put into the ice. The $\underline{\text{Cm}}$ means Latent Heat of Melting. Any numbers or letters underlined (other than those indicating solids) refer to big calories given out by a reaction, and the underlining is regarded as the " magic wand " which, as we have said before, takes the place of the sign of equality in ordinary chemical equations. We rarely use the oblique form when detached from Chemical Sequences.

HOH Cv -9.7 or HOH Cv -9.7 C.

The symbol Cv means LATENT HEAT OF VAPORISATION. As with Cm, it is here negative in quantity, because heat must be supplied from outside. We can have ice and water existing together, and these with the vapour of water, for both disappear by evaporation if left free to vaporise. We express such a mixture thus :—

HOH/ H O H / HOH as m/n/p

where m, n, and p are the relative weights of ice ,water, and vapour respectively. In this way the sign / means "along with," takes the place of the plus sign in chemical equations, and is never confused with the "magic wand," /.

SOLUTES.

When a salt dissolves in a liquid it loses the properties of a solid, its particles being free to move among one another. It has the appearance of a liquid. It seems to have melted. As heat aids fusion, so should it do to solution. With most salts this is so, but not with all. Common salt is almost as soluble at one degree as it is at one hundred. Whereas heat enables the particles of a solid to free themselves of the pull of their neighbours, it must be remembered that it also affects the water in an opposite direction, for a gas it has no solvent powers at all.

The opposing influences of heat upon a salt and its solvent are responsible in all probability for the irregularities of solution. Although looking like a liquid, a salt in solution called a solute, behaves like a gas, expanding under the influence of heat according to the gas law, and exerting pressure on the walls of the solution, like a gas. For these reasons a solute is represented by underlining thus : —.—.— with dot and dash line. A solution of sodium fluoride for example, in aqueous hydrofluoric acid would be represented thus :—

NaF/xHF/yHOH
—.—.—.—.—.—.—

Where a substance is only known in solution it is represented as a solute. For example, take manganese tetrachloride :—

$MnCl_4$
—.—.—

If we mix solutions of two salts such as sodium sulphate and barium chloride we get barium sulphate precipitated while sodium chloride goes into solution. We represent such a reaction thus :—

Na_2SO_4/BaCl - $BaSO_4$/2Na : Cl_2

The barium sulphate is represented as a solid, the others solutes. It will be seen that the SO_4 changes partners ,and is not itself split up. The two atoms of sodium keep together also. For that reason, when a salt is dissolved in water we represent it as splitting up into two parts which "float" about ready to take up new associates. Thus we represent a few solutes with their parts or ions separated by the sign : the sign of solution. The first part of each ionised salt is called the ION, and the second part the ANION. In ammonium sulphate, for example, the two groups (NH_4) are the ION *or* POSITIVE part, and the group (SO_4) the ANION *or* NEGATIVE part. The group N_2H_8 will always keep as such, and the group SO_4 pass to newer ions intact. This is seen when we mix two solutes as ammonium sulphate and lead nitrate. We get DOUBLE DISPLACEMENT or exchange of partners as we see from the following : —

$(NH_4)_2SO_4$/$Pb(NO_3)_2$ - $PbSO_4$/$2NH_4NO_3$

Here we see the two ammonium groups go over to the anion of nitric acid and the lead ion take on the anion of sulphuric acid, forming a solid lead sulphate or PRECIPITATE, which has not its parts free to move abont, but is what we call DEIONISED lead sulphate. When we are dealing with mixtures of solutes we need only indicate the precipitate, aud assume that the others are dissolved salts or ionised substances called SOLUTES. We will represent the two sequences or reactions by ionic notation thus :—

Na_2 : SO_4 : Ba : Cl_2 - $BaSO_4$/2Na Cl_2

On the left-hand side of the dash, which

means "produces at ordinary temperature," we have four things all ready to enter into combination with one of the others. We always write the formula with the positive or ion, first, and the negative or anion, second, thus referring to the sodium and barium as ions, and the other parts as anions. On the right-hand side we have a combination barium sulphate deionised, therefore not a solute but a precipitate, the two sodium atoms free to react on their own, and the two chlorine atoms also free. There is no necessity to indicate the positive portion ,as its relative position does so. We now give a list of substances ionised as they would be by dissolving in water, and then we will consider ELECTROLYSIS, as that is possible in aqueous solution.

Ammonium chloride NH_4Cl — ionised $NH_4 : Cl$.
Ammonium bichromate $(NH_4)_2Cr_2O_7$— ionised $(NH_4)_2 : Cr_2O_7$.
Potassium Chlorate $KClO_3$ — ionised $K : ClO_3$
Copper sulphate $CuSO_45HOH$—ionised $Cu : SO_4 : 5H : (OH)_5$.
Potassium copper chloride K_2CuCl_4— $K_2 : CuCl_4$.
Potassium ferrocyanide $K_4Fe(CN)_6$ — ionised $K_4 : Fe(CN)_6$.
Sodium hydrate NaOH—ionised Na : OH.
Water HOH—ionised H : OH.

Thus if potassium ferrocyanide reacts with another salt in solution, the potassium goes on its own to seek a new partner, and all the rest of the atoms after the : keep together to find a new head or ion to make a new combination.

Water we always write as HOH, ionised as H : OH, because the two hydrogen atoms are not held with theh same tenacity, for one comes away much more easily than the other, and water in its reactions tends to form compounds with this group OH, or HYDROXYL, as it is called. This group moves from the H to attach itself to another head or ion whenever it gets the chance, as we shall see later.

ELECTROLYSIS.

We shall understand, perhaps, the electrolysis of salts fairly well if we consider each salt as consisting of a positive and negative part, carrying charges of electricity like the anode and cathode respectively. We will indicate the electrolysis of water. Pure water ,it is said, does not conduct the electric current. Distilled water does so, according to the author's experience if the current density be high enough. There is certainly enough conductivity in tap water if the lighting current be taken, instead of the usual unsatisfactory accumulators. The current may be sent through three or four lamps. The electrolysis of water is shows as follows :—

$$2H)2H : (OH)_2(HOH/O$$

The two outer symbols) and (represent the cathode and anode respectively. Between them the action starts. It begins everywhere along the chain between them at the same time, even if that chain represent the Atlantic Ocean, and the signs) and (electric terminals dipped therein on the shores of Europe and America respectively. Outside these signs deionised substances are delivered. From the cathode we get hydrogen, and from the anode hydroxyl, which breaks up as showu into water and oxygen. The oxygen is delivered. We represent character of electric charge by relative position. As we usually represent a salt with the base or positive part first, we do so here. The positive electrode or anode, is placed to the *right*, and the negative electrode or cathode, to the *left*. Thus the positive charge on the anode neutralises the negative one on the hydroxyl and liberates that part of the salt touching it. Water is here considered as a salt. The negative charge on the cathode neutralises the positive one on the hydrogen, liberating that ion as a gas. As a molecule of water is not big enough to touch both electrodes, we assume a chain of water colecules, infinitely more numerous than is illustrated here :—

$$2H)2H : (OH)_2 : 2H : (OH)_2 :2H : (OH)_2 :2H : (OH)_2(HOH/O$$

We have here 4 water links in the chain between cathode and anode, each represented as $2H :(OH)_2$. The 2H is the positive part, and the $(OH)_2$ the negative. Between the signs of ionisation : each unit is free to join up with any other unit. The moment the current is switched on the 2H, and $(OH)_2$ at the ends of the chain are liberated, beyond them electrical action has ceased, and we do not come across the symbol of ionisation :. The ions in the chain now change partners, and the $(OH)_2$

of the extreme left takes on the 2H of number two. In this way all along the chain there is a change of partners, with a stepping into the chain of fresh water molecules to take the place of those which have been broken up. Common salt NaCl electrolysed, that is, decomposed by the electric current, if in a state of fusion, gives sodium at the cathode, and chlorine gas at the anode. When the salt is melted it is ionised, that is the head and the tail, or the ion and the anion, sodium and chlorine, are each free to unite with any other element or group, and free to slide or whirl round and about each other. They each carry electric charges, the metal ion a positive one, the chlorine anion a negative. The negatively-charged cathode discharges the positively-charged sodium ions as fast as they come in contact with it. The positively-charged anode does likewise to the negatively-charged chlorine anions. If we remember that we do not have like charges next to one another, and that the first part of a salt written down, namely the base or metal is positively charged, the rest is easy. Thus with sodium chloride we have Na)Na :Cl(Cl, which shows a molecule of ionised salt deionised by the electrodes) and (yielding the metal sodium and the gas chlorine. If these carried charges they would not be outside the signs) and (and would be separated by the sign : the ion on the left, the anion to the right. The reason *why this sign is placed all along the chain in* other cases is because anions transfer their affinity from the partner on their right to that on the left. As the left-hand member of the molecule is a metal we so regard hydrogen in water, and write the formula as HOH.

We do not write it H_2O, as the group OH wherever possible keeps intact and takes on other metals as hydroxides ,such as copper hydroxide $Cu(OH)_2$ and iron hydroxide $Fe(OH)_3$. If this metal sodium be thrown into water it floats on the top, liberating hydrogen and forming sodium hydroxide NaOH thus :—

Na/HOH - NaOH/H

Here we have a chemical sequence, not an electrolytic chain, which means that an atom of sodium reacts with a molecule of water to produce a molecule of sodium hydroxide and an atom of hydrogen. This reaction takes place without the assistance of heat as is indicated by the sign -. The expression does not say whether the reacting substances are solid, liquid, or gas. If we take a solution of common salt and pass the electric current through it we get no sodium, but hydrogen and chlorine given off, and caustic soda or sodium hydroxide added to the water. The reaction is represented in CHAIN form, thus :—

H)H : OH : Na : Cl(Cl

Thus we see that immediately the chlorine is deprived of its negative charge and liberated, the nascent sodium fully charged turns on the OH and snaps it from the hydrogen, as this latter has no further interest therein, having been robbed of its positive charge by the cathode. It is easier for the sodium ion to break up water where assisted by the cathode than to turn to attack anothed Molecule of NaCl. By underlining we indicate what is added to the electrolyte. In this case it is sodium hydroxide in the form of a solute.

We have not so far indicated the nature of the electrodes. These signs are used for anode (and cathode), where there is no action on them by the reacting substances, hence they are of platinum, carbon (except where oxygen is given off), or ferro-silicon, or stainles steel (Messrs. Firth's). This last is infinitely better than platinum, as it is almost everlasting and offers much greater surface than platinum gauze ,on account of its price. Carbon forms the monoxide with oxygen, but is the best substance for the halogens. With Firth's stainless steel, two electrodes 5 mms. thick will deliver sufficient gas to be tested in half an hour, whereas with the Hoffman's apparatus this takes 3 or 4 hours and therefore is of no use for demonstration purposes. We can indicate the nature of an electrode by placing the symbol referring to it between two signs thus :—

$$2H)2H : (OH)_2(C(HOH/CO.$$

The cathode is unacted upon, therefore, its nature is not indicated, but the anode is of carbon, cannot affect the water, HOH, but forms CO with the oxygen. As the formation of this CO is chemical such a fact is shown by the sign /, otherwise we should use the sign of ionisation, namely :. When we are dealing with electrolysis, this sign

cannot be used outside the signs) and (. Sir Humphrey Davy isolated sodium and potassium from their hydroxides by means of the electric current, usiug a mercury cathode which unites with the sodium, provided there is not too much water about, thus :—

$$Na_xHg_y)Hg)2Na : (OH)_2(HOH/O$$

a parallel with the electrolysis of water sodium being in the place of hydrogen, which latter would not amalgamate with the mercury. The author has noted that water is electrolysed, giving fresh sodium hydroxide according to the following chain :—

$$2H)Hg)2H : (OH)_2 : 2Na : (OH)_2(HOH/O$$

The mercury cathode does not react with the hydrogen and need not be indicated. Water is broken up faster than it is produced as the liquid is electrolysed. Only sifficient remains eventually to ionise the sodium hydroxide, without which conductivity would cease. Note that the formula of water is given generally as HOH, but its formula must be more complex than that, as is probably the case with all our liquid compounds where the vapours do not have the density agreeing with the simple formulæ at their boiling points. As we do *not* know the true formula we write that which suits our chain, and water is 2H.2(OH) or 2HOH, written $2H : (OH)_2$ still for convenience. Such a formula does not mean $2H(OH)_2$ as that would be $H_2O_4H_4$, but merely 2H free and independent of 2OH.

Electrolysis of Alkalis and Earths.

The electrolysis of the alkali chlorides or of the alkaline earth chlorides fused gives the metal thus :—

(i) Li)Li : Cl(Cl, (ii) Na)Na : Cl(Cl, (iii) K)K : Cl(Cl, (iv) Rb)Rb : Cl(Cl, (v) Cs)Cs : Cl(Cl, (vi) Ca)Ca : Cl_2(2Cl, (vii) Sr)Sr : Cl_2(2Cl, (viii) Ba)Ba : Cl_2(2Cl. Other chlorides yield the metal in the same way such as $CuCl_2$, AgCl, $ZnCl_2$, $CdCl_2$, $LaCl_3$, $CeCl_3$, $PrCl_3$, $NdCl_3$, $SmCl_3$, TlCl, $PbCl_2$, VCl_4, $SbCl_3$, $BiCl_3$, $MoCl_5$, WCl_6, UCl_4, $HgCl_2$, and also of the non-metals, though some of these show determined tendency to give the oxide if there is the least air or water near. Concentrated solutions with a mercury cathode give an amalgam of the metal thus : Km)Hg)K : Cl : H : OH(OH,
—.—.—

H)H : Cl : H : OH(OH, and H)H : Cl(Cl.
—.—.—

Thus we have given off Km (mercury amalgam of potassium), H, Cl (as saturation is reached), and 2OH giving HOH and O. All these are delivered with saturated solutions of the alkalis and alkaline earths. It is the middle reaction of the three given above which helps the other two by the loss of water.

Potential Transference.

Any of the first nine metals given above will decompose water, without the aid of heat, thus :— Ca/2HOH — $Ca(OH)_2$/2H. Other metals do so on heating. One of

these is aluminium 2Al/3HOH t Al_2O_3/6H. We indicate under the dash, or "magic wand," the nature of energy which has to be supplied to the system from without. As there is no fear of confusion arising from so doing we incline the dash. The letter t means "Temperature Must be Raised," and our sequence may be written :—

$$2Al/3HOH\ /t\ Al_2O_3/6H.$$

Copper is not one of these to decompose water when thrown into it, even when heated. If, however, copper be thrown on the floor of an electrolytic cell containing water, and the current be passed, blue-green hydrate is formed. The electrodes in neutralising hydrogen and hydroxyl respectively, give a sort of nascence to the "waltzing ions," a kind of transference of the electrodes' potential rendering the water corrosive, for cupric hydrate is most certainly formed without the assistance of any acid whatever. The same occurs with other metals having ordinarily no action on water, the hydrate or oxide being formed. The gas given off by the metal is a mixture of hydrogen and oxygen, mostly hydrogen. We may look upon the metal as a Compound Electrode or Idle Electrode, negative on the *right-hand side* and positive on the other. It is unattached, but acts towards the anode, thus, in the case of copper :—

$$2H)Cu)2H : (OH)_2(HOH/O,$$
— — — —

hydrogen being given off at the metal and oxygen at the anode. Towards the cathode it acts as an anode, thus :—

$$2H)\underline{2H : (OH)_2}(Cu(CuO_2H_2.$$

The electrolyte is underlined.

Zinc is oxidised thus :—

$$2H)Zn)\underline{2H : (OH)_2}(HOH/O$$

between zinc and anode.

$$2H)\underline{2H : (OH)_2}(Zn(ZnO/HOH,$$

between zinc and cathode.

Reference has been made (*Chem. News*, November 20, 1925), to the ionising power of the electric current. Acids and alkalis are rendered stronger in their action thereby. Water is supposed to be a neutral compound. We have no scale of acidity and therefore cannot say that any salt is neutral. It can only be said to be neutral to certain indicators. However, we can roughly accept the conception that hydrogen and hydroxyl neutralise one another. So do caesium and chlorine, or caesium and fluorine. Yet we should never think of hydrogen as so strong a base as caesium, or hydroxyl as strong an acidic radical as fluorine or chlorine. We therefore awaken strong basic and acidic potential in ionising caesium chloride. Such awakening proceeds from electrolysis. Where an electric charge is neutralised by an electrode the attendant partner seems to acquire a *sudden spring of potential* that enables him to snap away his neighbour's "better half," or do things he could not do under the influence of ordinary solution

Magnesium in water electrolysed gives off hydrogen mixed with some oxygen in a good stream of bubbles, even when placed beyond the electrodes, that is, not in the line between them. The hydrate is carried upwards by the stream. Cadmium behaves similarly, but less vigorously. Mercury placed in a blob on the floor of a glass cell between the electrodes, darkens on the side nearer the cathode, while the other side remains bright, showing a clean cathode and an oxidising anode, and visually demonstrating the dual character of the idle electrode. It is so called because it supplies no potential, but splits up its charges by virtue of being in the way of the electric stream. A few cases of the corrosive action of electrolysing water will be given. Cathode first :—

(i) $3H)\ \underline{3H : 3(OH)}\ (Al(\underline{Al(OH)_3},$

$$2H)\ \underline{2H : 2(OH)}\ (HOH/O,$$

(The aluminium is not indicated in the second (anode) part because it does not apparently enter into the reaction.)

(ii) $3H)\ \underline{3H : 3(OH)}\ (Fe(\ \underline{Fe(OH)_3},$

$$2H)\ \underline{2H : 2(OH)}\ (HOH/O$$

(iii) $3H)\ \underline{3H : 3(OH)}\ (Cr(\ \underline{Cr(OH)_3},$

$$2H)\ \underline{2H : 2(OH)}\ (HOH/O$$

(iv) $2H)\ \underline{2H : 2(OH)}\ (Pb(\ \underline{PbO_2}/2H,$

$$2H)\ \underline{2H : 2(OH)}\ (HOH/O$$

(v) $3H)\ \underline{3H : 3(OH)}\ (Bi(\ \underline{Bi_2O_3}/3H.$

$$2H)\ \underline{2H : 2(OH)}\ (HOH/O$$

Anodic Oxidation.

If the anode of an electrolytic couple be used to electrolyse water it will be oxidised as are the above, the hydrate being formed wherever possible. The sequence is written giving the first half of the above, the metal being indicated between the two anode symbols. With a metal like platinum there is no oxide or hydroxide (also called hydrate) formed. Consequently there is the full discharge of oxygen thus :— $2H)\ \underline{2H : 2(OH)}\ (HOH/O.$

Where the anode is of carbon, carbon monoxide is formed— $2H)\underline{2H : 2(OH}\ (C(HOH/CO.$ Tungsten is oxidised to the trioxide, showing beautiful colour changes— $3H)\ \underline{3H : 3(OH)}\ (W(\ 3HOH/WO_3.$

If hydrochloric acid solution be used instead of water the action is very much more brisk. With a very weak solution the behaviour is the same as with water. The hydrochloric acid HCl is not used up. This may be represented thus :—

(i) 2H) 2H : 2Cl : 2H. 2(OH) (Cu(

$Cu(OH)_2$

Thus the 2H is given off at the cathode, the 2Cl turns to the 2H of the water, whose 2(OH) joins the copper. As we are no longer dealing with a simple liquid, we underline the electrolyte as a solute. Other cases should present no difficulty ,for example, aluminium, etc. :—

(ii) 3H) 3H : 3Cl : 3H : 3(OH) (Al(

$Al(OH)_3$.

PROGRESS IN REFRIGERATION.

By A Well-Known Engineer.

The most remarkable advances are being made to-day in refrigeration, a subject which, of course, is directly interestiug to many branches of the chemical industry, such as nitrating, including explosives, and diazotising in connection with the manufacture of azo dyes.

The recent 16th Annual Convention of the National Association of Practical Refrigerating Engineers in the United States, held in Detroit a short time ago, showed in a striking manner the progress that is being made, both technically and in the growing application of the principle in many different fields. The most familiar example is, of course, the transport and cold storage of foodstuffs, and it may be stated that the value of material of this description imported into Great Britain every year by the aid of refrigeration is over £100,000,000. This includes over half the total meat consumption of the country, which, in 1924, for example, was valued at £47,000,000. The latest developments in the United States, however, include the use of refrigeration for bread-making, the manufacture of chocolates and sweetmeats, and for cooling water and oil used for tempering, quenching, and similar purposes in the engineering industries.

The most important new field, however, is the household refrigerator operated continuously by means of a small electric motor, say half-horse-power, or less, and which, for a sum of something like £100-£150, enables all the household food supplies to be kept under the best conditions, and provides all the ice required.

As regards the technical side of refrigeration, one of the chief papers at the convention in Detroit dealt with the scientific control of refrigerating plant, including the continuous recording of the amount of condenser water pumped per ton of ice, the temperature differences between the water, the liquid ammonia, and the brine, and the velocity of the latter through the circulating pipes. Further points also dealt with included the methods of driving the ammonia and the brine pumps, the struggle for supremacy being between the "Uniflow" steam engine, the internal combustion Diesel oil engine, and electric motors, while another very important feature is the lagging of the refrigerator pipes and chambers.

In the latter connection the modern scientific practice is to use slabs of granulated cork which have first been compressed and then subjected to baking so as to drive off every trace of moisture and volatile content in the raw cork, such as supplied, for example, by Messrs. Sutcliffe Bros., and Bryce, Ltd., of Hyde, near Manchester. Cork is, of course, well-known to be almost ideal material for this purpose, both as regards non-conductivity to heat and resistance to mildew, and the above methods still further acceutuate its advantages.

The whole question of the scientific principles underlying the insulation of refrigeration chambers was dealt with by Mr. James Hatton, M.I.Mech.E., a director of the above firm, in a paper read at the Fourth International Refrigeration Congress, held in London, and here again the progress made during the past few years has been very rapid.

General Notes.

NEW HOLLINGER HOISTS CAN HANDLE 12,000 TONS PER DAY.

The two largest hoists ever used in Canada are now *en route* to Timmins for installation by the Hollinger Consolidated Mines, Ltd. These hoists have a capacity of 560 tons of ore per hour from a depth of 3,200 feet to the surface, or of 12,440 tons per day. This is more than double the present mill capacity of the Hollinger Mine and fifty per cent. above the statement of an ultimate mill capacity of 8,000 tons

a day, which the Hollinger management hopes to attain.

Both these hoists, with their complete mechanical and electrical equipment, are being supplied by the English Electric Company of Canada, Ltd. The heavy equipment has just been completed in Great Britain. The steel hoist drums are 12 feet in diameter, and 12 feet wide. A third giant hoist for the new McIntyre shaft is also being made in England at the present time.

HELIUM IN ONTARIO.

The gas in certain natural gas wells at Inglewood, in the township of Caledon, Peel County, Ontario, contains helium in proportions large enough to warrant extraction. It is believed that these wells are the only known source of this rare gas in commercial quantities in the British Empire. The gas is found in the Dundas (Lorraine) shales of upper Ordovician age, at a depth of 400 to 600 feet. There are three producing wells, all of comparatively small output, but the limits of the gas field have by no means been reached, as gas has been found in small quantities at the same horizon over a widespread area. The helium content is 0.8 per cent.

WESTERN CANADIAN INDIANS REAP BIG GRAIN HARVEST IN 1925.

The Indians of the Prairie Provinces in 1925 reaped over a million bushels of grain —roughly 850 carloads—and had on their farms fifty thousand head of live stock. Canada, taking from the beginning the stand that the Indians were the wards of the nation, has done for them probably more than any other country, colonised in modern times, has done for its aborigines. The effort of the Government has always been not to pauperise the Indians but to lead them to a position of self-support under the new conditions.

Some of the details are interesting and informative. There are, according to the last census 30,934 Indians in the Prairie Provinces, divided at follows: Manitoba, 11,673; Saskatchewan, 10,271; Alberta, 8,90. The reserves in which these Indians live contain some of the finest land in Western Canada, particularly those situated in Saskatchewan and Alberta. The Indians of Manitoba own some splendid land but most of them live in the northern part of the province where little farming can be done, and where they earn a livelihood by hunting and fishing. In Alberta, Indian reserves cover 1,307,343 acres; in Saskatchewan, 1,195,674 acres, and in Manitoba, 415,477 acres.

Farming and stock raising are and will be the main occupation of the Indians of the Prairie Provinces and in these lines they have been very successful. In 1924 the number of Indian farmers was 1,718 and they grew 898,464 bushels of all grains. In 1925 the crop harvested from Indian farms reached 1,142,933 bushels made up of 552,586 bushels of wheat; 495,779 bushels of oats; 94,153 bushels of barley; and 515 bushels of other grains.

ODOURLESS CARBON BISULPHIDE.

A method for producing odourless carbon bisulphide was described recently by Dr. Karl Bohm von Bornegg in the *Chemiker-Zeitung*. The liquid is shaken up with mercury, separated from the mercury and allowed to stand for a short time in the presence of 2 per cent. of pure fat. On subsequent distillation, the carbon bisulphide is obtained in a practically odourless condition. The mercury treatment may be omitted, but the results are not so satisfactory.—*Canadian Chemistry*.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

At the meeting held on February 25, 1926, the following papers were read :—

Critical Potentials of Hydrogen in the Presence of Catalytic Nickel and Copper. By J. H. WOLFENDEN. Communicated by Prof. E. F. Armtsrong, F.R.S.

Several criticisms are advanced which seem to render invalid Gauger's measurements of the critical poaentials of hydrogen in the presence of catalytic nickel.

A modifiqed apparatus is described in which measurements of ionisation from hydrogen in the presence of catalytic nickel, plain nickel, and catalytic copper were made. By comparison of these

results with those obtained when molecular hydrogen was the preponderating source of ionisation, it is concluded that substantial quantities of atomic hydrogen are present at the metal surface in each of the three former cases. It is shown that a similarity exists between the effect upon the form of the ionisation curve of the presence of the catalyst metal and that of an incandescent grid (as determined by Olmstead). The results are of significance in connection with the mechanism of catalytic hydrogenation.

Adsorption Experiments with Radium D and Radium E. By J. P. McHutchinson. Communicated by Prof. G. G. Henderson, F.R.S.

The results enumerated in this paper may be summarised as follows :—

(1) Previously known facts regarding the adsorption of a single radio-element from its solution, either by a precipitate formed in the solution or by an added solid, are in general found to hold for the cimultaneous adsorption of the two radio-elements, radium D and radium E, when present in radio-active equilibrium. But it is pointed out that the results in several cases are influenced by abnormal adsorption effects.

(2) Isotopic precipitates possess no greater adsorptive powers than certain non-isotopic precipitates, which can completely carry down the radio-elements.

(3) But an isotopic precipitate, formed under such conditions that one of the two analogous radio-active compounds is soluble, exhibits a preference for its own isotope, whereas a non-isotopic precipitate displays no such preference.

(4) The addition of a soluble lead salt to a solution of radium D and radium E stops the adsorption of radium D by charcoal, and in this way radium E has been extracted in a state of great purity.

(5) The half-life period of radium E has been so determined as 4.9 days.

(1) *High-Temperature Oxidation of Metals.* (2) *The Low-Temperature Oxidation of Copper.* By J. S. Dunn. Communicated by Dr. W. Rosenhain, F.R.S.

(1) The oxidation of three copper-zinc alloys has been investigated and shown to be controlled by diffusion through a protective film of oxide. The rate of oxidation has been shown to vary exponentially with the temperature.

A theory of diffusion in solid solutions is outlined, and by the application of statistical laws to thermal agitation of solids, an expression for variation of diffusion rate with temperature is deduced, which is in formal agreement with experimental law.

The results of Roberts Austen and Van Ostrand and Dewey upon diffusion of gold in lead are shown to be in harmony with this hypothesis.

(2) Oxidation of copper in its normal commercial state is shown to follow the theoretical parabolic law over comparatively short-time intervals.

Oxidation of catalytically active copper is shown to proceed more rapidly than normal copper, but the parabolic law is not obeyed.

The origin of this departure from the ideal law is traced to changes occurring in the oxide film, and a general parallel is established between catalytic behaviour and oxidation rate.

The experiments described are considered to throw light upon the nature of catalytically active copper, to which a disperse structure has been ascribed.

A Note on the Significance of the Electrode Potential. By J. Heyrovsky. Communicated by Prof. F. G. Donnan, F.R.S.

1. It is explained that the stages of the author's cycle, denoted by J. A. V. Butler as irreversible, involve the correct free energy terms.

2. Mr. Butler's proof, that the author's potentials round the cycle are zero, is shown to be faulty owing to Butler's transfer of electrons over the metal-solution-vapour interface instead of bringing them over the dry metallic surface outside the cell. When this wrong step is avoided, it leads to the same relation between the electrode potential and the basic and ionisation constants, as has been deduced by the present author, thus furnishing a further proof of the correctness of the deductions made by the latter.

THE CHEMICAL SOCIETY.

The following papers were read at the meeting held on March 18, 1926.

Orientation Effects in the Diphenyl Series. Part II. The Constitution of Bandrowski's Dinitrobenzidine. By R. J. W. Le Fevre and E. E. Turner.

Cain and his co-workers (*T.*, 1912, CI.,

2298, and later papers) described a new kind of isomerism in the diphenyl series. The authors have repeated Cain's work, and have prepared the two compounds; Bandrowski's compound is mainly 2 : 3′-dinitrobenzidine.

The Orientating Effect of Free and Bound Ionic Charges on Attached Simple or Conjugated Unsaturated systems. Part I. The Nitration of Some Benzylamine Derivatives. By H. R. Ing and R. Robinson.

Benzylpiperidinium nitrate and dibenzylmethylammonium nitrate are largely nitrated in the *m*-position whilst benzyltrimethylammonium nitrate gives a high yield of the *m*-nitro-derivative. On the other hand diacetobenzylamide and benzylphthalimide are attacked by nitric acid in *o*- and *p*-positions in the benzyl group. The views of Holmes and Ingold on the course of the nitration of benzylamine and some derivatives are criticised, and it is shown that contrary to the conclusions of these authors, it is the benzyl-ammonium salts which are nitrated in the *m*-position.

The Morphine Group. Part IV., A New Oxidation Product of Codeine. By R. S. Cahn and R. Robinson.

The oxidation of codeine by means of potassium permanganate in very dilute aqueous solution leads to the formation of dihydroxydihydrocodeine and this result affords further evidence in favour of the view that codeine contains an ethylenic linking.

The Laws of Aromatic Substitution. Part. V., The Directing Effect of Electrolytically Dissociated Groups. By B. Flurscheim and E. L. Holmes.

By nitrating benzyldiethylamine in sulphuric acid, Noelting and Kregczy obtained 35 to 40% of *m*-nitro-derivative. The present authors found the corresponding yield to be 44%. When the concentration of the amine in the nitrating acid was halved, the percentage of m-derivative rose to 52%. When the nitrating solution was saturated with ammoninm sulphate it was 34%. *m*-Nitration runs parallel with the degree of electrolytic dissociation, approximately in accordance with Sugden's cubic law, and is exclusively due to the electrolytic ion. The undissociated salt is nitrated in the *o*-*p*-positions, in agreement with the *m*-chlorination of undissociated benzoic acid, the *o*-*p*-chlorination and of its ion, and in accordance with the theory of an alternating distribution of affinity, but contrary to Robinson's theory. Since an electrical charge may be regarded as by far the most polar element, its attractive effect on an atom of opposite polarity, and its repulsive effect on an atom of similar polarity, must far outweigh the corresponding action of two such atoms on each other.

The Velocity of Decomposition of Heterocyclic Diazonium Salts. Part II. The Aminopropyltriazoles. By J. Reilly and P. J. Drumm.

Alkylation in heterocyclic rings appears to stabilise the diazonium salts from these aminoalkyl compounds. In this connection, the authors have examined the aminopropyltriazoles which were obtained from aminoguanidine nitrate by the action of *n*- and *iso*-butyric acids. As in the case of amino-triazole oxyacids were employed in the diazotisation and the diazo-nitrogen was not completely evolved even after several hours' heating at 55° with acid (6 mols). The diazonium chlorides ,in presence of excess of hydrochloric acid were also comparatively stable, although chloroalkyltriazoles were readily obtained from them. In presence of sodium acetate the *iso*diazohydroxides are easily formed, and in this respect these bases behave differently from the ordinary aromatic compounds. The two diazopropyltriazole chloroaurates have also been obtained.

The diazonium salts couple with β-diketones to give 3-propyl-1 : 2 :4-triazole-5-azoacttylacetone and 3-propyl-1 : 2 : 4-triazole-5-azoacetoacetic ester. The reactivity of the aminogroup in the triazole ring was indicated by the great ease with which the base gave condensation products with aldehydes (*e.g.*, with cinnamaldehyde and salicylaldehyde.) These triazoles possess both basic and acidic properties as is shown by the formation of a hydrochloride and of a silver salt. The aminopropyltriazoles were fairly stable towards oxidising agents. Oxidation with alkaline permanganate led to the formation of an azotriazole, which on reduction gave an hydrazo-compound. As in the case of aminomethyltriazole, reduction of the diazonium chlorides with stannous chloride led to the formation of a hydrazine isolated as its its benzaldehydehydrazone. This hydrazone readily lost its benzaldehyde on treatment with dilute acids and the free hydrazine reduced Fehling's solution in the cold.

THE INSTITUTE OF METALS.

ANNUAL GENERAL MEETING.

The following summaries of papers were presented at the Annual General Meeting, held on March 10, 1926.—

Note on the Softening of Strain Hardened Metals and its Relation to Creep. By R. W. BAILEY, B.Sc., Wh.Sc., Member.

The author suggests that the creep of a metal under stress is the necessary accompaniment of the softening or reduction by thermal influence of a strain hardened condition and its simultaneous recreation by further slip or strain. Thus, for example, it is suggested that under a given stress the rate of extension of a piece in tension is determined by the rate of softening, which in turn depends chiefly upon the temperature.

The softening characteristics of strain hardened metals are examined and it is shown that there is good reason to believe that generally the mechanism of softening is a definite characteristic of a metal uninfluenced by temperature except as to the rate of its progress ,and further, that it takes place at all temperatures. It is shown that the law of softening is well represented by the relation :

$$T = To\, \epsilon - b\theta;$$

where T is the time to produce a given degree of softening at a temperature of θ deg. C.; To is the corresponding softening time for a temperature of 0 deg. C; b is a constant for a given material which ranges in value from 0.05 to 0.09 for the metals examined; and e is the base of the Naperian logarithms.

The author indicates that, neglecting the variation of the physical properties with temperature, which is of only secondary importance compared with the influence of temperature upon the rate of softening, a similar law would be expected to connect the life and temperature of a piece subjected to a given stress. It is stated that Dickenson's results support this deduction and consequently if L is the life of a test piece at θ deg. C., and Lo is the corresponding life at 0 deg. C., the relation between life and temperature is given by :

$$L = Lo\, e - b\theta$$

The author finds that for the metals used, Dickenson b has a value ranging from 0.046 to 0.07.

In questioning whether there is a limiting creep stress the author states that a critical examination of published data shows that in most cases the limit of accuracy of the apparatus or method used has been mistaken for such a stress.

Note on the Corrosion of an Ancient Tin Specimen. By PROFESSOR C. O. BANNISTER, M.Eng., A.R.S.M., F.I.C., Member.

This note contains the results of the examination of an ancient tin sheath, the metal portion of which contained 99.98 per cent. tin. The metal was covered with a corrosion product, which contained 76.82 per cent. tin and 5.1 per cent. combined water. On driving off this water by heating in air, the product showed a loss of only 0.59 per cent., indicating that it had gained 4.51 per cent., oxygen. These results show that the product contained hydrated stannous oxide 43.35 per cent., and anhydrous stannic oxide 54.68 per cent. The mechanism of corrosion of metallic tin, therefore, comprises the formation of hydrated stannous oxide and the subsequent oxidation and dehydration of this compound to stannic oxide.

Some Experiments on the Soft Soldering of Copper. By T. B. CROW, M.Sc., Ph.D., Member.

The paper deals principally with the intergacial effects which arise between soft solder and copper when the latter is soldered under conditions which do not represent industrial practice—the author's contention being that the effects observed and recorded in a series of photo-micrographs are simply "enlargements" of those which would occur under industrial conditions; and that his method of experimenting is a convenient device for studying effects which may be ultra-microscopic under ordinary soldering conditions. The wide scope of the subject is indicated and suggestions and criticism upon the many theoretcal issues which it involves, and the difficulties attending a full investigation of the mechanism of soft soldering generally (as hrought to light in this paper, from work upon the soldering of copper) are invited.

The photo-micrographs shew evidence of having been prepared with great care and should be of value in that they represent something new in this direction; the interfacial effects are most strikingly shewn—a region which in many existing photo-micrographs is little more than an out-of-focus

blur. A number of experiments upon matters which arose from a study of the microstructure, *viz.*, (1) the solution of the copper by the "solder"; (2) the effect of pressure (applied during joining) upon the structure and mechanical properties; (3) the identification of the interfacial alloys is described.

The results of the experiments and of certain suppositions are summarised in a general theoretical résumé at the end of the paper. References to revelant publications (including one of the author's of which the present paper forms a continuation) are given.

The Determination of Zinc Oxide in Brass. By B .S. Evans, M.C., M.B.E., Ph.D., B.Sc., F.I.C., and H. F. Richards, B.Sc., A.R.S.M.

A description of a method for the determination of zinc oxide in brass based on the fact that the back reaction $Zn + H_2O = ZnO + H_2$, which occurs when an attempt is made to estimate zinc oxide by Archbutt's method for estimation of oxygen in copper (*Analyst*, 1900, XXV., 253), can be suppressed by the presence of sufficient copper to combine with the zinc volatilised from the sample. The estimation is carried out in the same apparatus and in much the same manner as for determination of oxygen in copper, but that part of the furnace tube which is not occupied by the boat is packed with tightly rolled copper gauze. The copper gauze is deoxidised by prolonged heating in a current of hydrogen, the furnace is then allowed to cool the sample (a lump of about 80 grammes) introduced, the packing replaced, and after sweeping out the air with hydrogen, the furnace is heated up to 980° C., and kept at this temperature until the rate of gain in weight of the phosphorus pentoxide U tube has dropped to that of a predetermined blank. The water evolved is estimated by the gain in weight of the phosphorus pentoxide U tube after deduction of the blank. Owing to the small amount of oxide which occurs in brass, somewhat elaborate precautions have to be taken to reduce the blank to a minimum; these involve additions to the purifying train and measurement of the amount of hydrogen passed.

Crystal Growth in Recrystallised Cold-Worked Metals. By W. Feitknecht, Dr.Phil., D.I.C.

The experiments described in this paper deal with the changes of structure in cold worked metals after recrystallisation is completed. They were mainly carried out with pure commercial aluminium (99.6 per cent.), but some work was also done with very pure aluminium (99.98 per cent.), and pure assay silver.

It is shown that, after recrystallisation was completed, all further changes of structure on prolonged annealing were due to the growth of existing crystals, both when the temperature was kept constant and when it was raised. No crystals were observed to start from new nuclei. No relation between the size and shape of the crystals and the capacity to grow could be detected. The growth was faster, the more severely worked the sheets had been before recrystallisation.

The final size that the crystals reached after growth had come to a standstill, increased with decreasing deformation. In the pure commercial aluminium, in the moderately worked samples, very large crystals were formed. Below a certain limit of deformation no considerable change took place after recrystallisation was completed.

A previous heat-treatment at a certain temperature had a considerable effect upon subsequent growth at another temperature and upon the final crystal size. In sheets thinner than 0.75 mm., the crystal size decreased with decreasing thickness of the samples, and in very thin sheets no considerable growth took place after recrystallisation was completed. In the very pure aluminium the growth was much quicker than in the pure commercial aluminium. The pure assay silver behaved much like the very pure aluminium, but the crystals did not grow so large.

An endeavour is made by the author to explain the observed facts by assuming that the crystals formed during recrystallisation were still strained, and that on heating further the least strained crystals absorbed the crystals having the most remaining strain.

THE INSTITUTE OF PHYSICS.

The following have been elected to Corporate Membership :—

Fellows : M. Baldwin, B. Dasannacharya, W. H. George, R. Hosking, Sir Richard Paget, Bart., T. Parnell.

Associates : Irene E. Bocking, J. C. Mann.

NOTICES OF BOOKS.

Untersuchungen und Nachweis organischer Farbstoffe auf spektroskopischem Wege. von PROF J. FORMANEK AND PROF. J. KNOP. Pp. 368 to 574 with plates. Berlin: Julius Springer, 1926. Price 36 marks.

This section of the handbook on the spectroscopic data of organic dyestuffs refers chiefly to yellow compounds which are soluble in water, alcohol, or amyl alcohol. Besides strictly yellow dyes, those of orange yellow, greenish yellow and brownish shades are also included. They are classified spectroscopically into nine groups. In the first group are those dyes which, in solution ,show only one symmetrical absorption band, *e.g.*, most acridine dyes, a few azo-compounds, and quinoline yellow. Those in group II show a strong main absorption band and a subsidiary weak one. Among these are a few acridine, and azo dyes and fluorescein compounds; and so on.

It is pointed out that solutions of many dyestuffs show a green fluorescence which is usually dependent on the nature of the solvent.

An account is given of spectroscopic apparatus and its use. The Czech authors have apparently exclusively used German instruments, those of well-known German makers being figured in the text.

By far the greater part of the book is taken up with tables of absorption spectra and this data should prove of considerable value to workers in this field.

Explosifs, Poudres, Gaz de Combat, par PAUL PASCAL. Pp. 296 + VIII. Paris: 1925, Librarie Scientifique, J. Hermann. Price 35 francs.

This book, which has been written for the chemical engineering students at Lille, a number of whom take the entrance examination of the *Services des Poudres*, is divided into four parts. The first part deals with the explosive reaction; part two is concerned with the manufacture of explosives; part three deals with explosive mixtures and propellants; and part four with war gases. It contains, apparently, very little that is new, but the author has collected together much information made available since the war.

It is a melancholy reflection to find that the spirit of Locarno is not likely to penetrate very deeply into the minds of the Nations of Europe ,for it is evident that large numbers of students in France are receiving information on the destructive and annihilating powers of these compounds obtained through the skill of the chemist. It is idle to suppose that all this information can be given for pacific purposes only.

J. G. F. D.

RECENTLY-RECEIVED PULICATIONS.

Analyses of Alabama Coals (U.S.A. Bureau of Mines)—*Properties of Typical Crude Oils—Phosphate Rocks in 1924—Initial Temperature and Mass Effects in Quenching—Relation between Heating Value of Gas and its Usefulness to the Consumer—Radio Frequency Resistance and Induction of Coils Used in Broadcasting Reception—Standards for Paper Towels—Government Specification for Fire Clay, Slate Surfaced Asphalt, Textile Materials, Rubber Bands, Gas Hose, Asphalt—Satitrated Woven Cotton Fabric for Waterproofing—Standard Time throughout the World* (United States Bureau of Standards, Washington, D.C.).

FORTHCOMING EVENTS

ROYAL INSTITUTION OF GREAT BRITAIN.

21, Albemarle Street, W.1.

Friday, March 26, at 9 p.m. Sir Ernest Rutherford, O.M., LL.D., D.Sc., F.R.S., M.R.I. Prof. of Natural Philosophy, R.I., and Cavendish Prof. of Experimental Physics, University of Cambridge.

ROYAL SOCIETY OF ARTS.

John Street, Adelphi, London.

Monday, March 29, at 8 p.m. (Cantor Lecture). W. F. Higgins, M.Sc., National Physical Laboratory, "Thermometry." (Lecture III.)

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

5,218.—Bentley, W. H., & Blythe & Co., Ltd., W., & Catlow, B.—Manufacture of lead nitrate. February 24th.

5,241.—Burdin, H.—Manufacture of carboys, etc. February 24th.

5,046.—I. G. Farbenindustrie. Akt-Ges. —Manufacture of di-ammonium phosphates. February 22nd.

5,422.—Jahl, A.—Production of barium sulphate from barium sulphide. February 25th.

5,879.—Brus, G.—Manufacture of synthetic camphor. March 2nd.

5,635.—Cooke, E. A.—Purification of natural soda. March 1st.

6,010.—L. G. Farbenindustrie Akt.-Ges. —Manufacture of ammonium phosphates. March 3rd.

6,231.—Parker, J.—Separation of tar and ammonia from gases. March 5th.

5,918.—Soc. of Chemical Industry in Basle.—Manufacture of quinolic anhydride. Marcb 2nd.

Specifications Published.

232,909.—Naugatuck Chemical Co.—Manufacture of styrol and its homologues.

247,261.—Badische Anilin & Soda Fabrik. —Manufacture and production of vat colouring matters.

247,405.—Niccoli, E.—Process for the production of potassium salts.

232,206.—Staudinger, H.—Manufacture of esters of 4-oxy-piperidine derivatives.

247,471.—Millar, W. S.—Desulphurization and concentration of sulphide iron ores.

247,644.—Mills, W. G., and Packards & J. Fison (Thetford), Ltd. — Lead chambers employed in the manufacture of sulphuric acid.

Abstract Published.

245,687.—Obtaining urea from solutions.—Badische Anilin & Soda Fabrik, Ludwigshafen-on-Rhine, Germany.

Spray evaporators crystallising.—Urea in a sandy condition capable of being easily psread for use as a fertiliser is obtained by distributing hot concentrated urea solution as a coarse spray into hot or cold air or other gas. The product may be further dried, if necessary, in revolving furnaces, vacuum driers, etc., or mother liquor may be separated by centrifugal means. The distribution of the solution may be effected by a current of cold or hot air blown across a jet of the solution or by dropping the solution on to a rotating disc. Specification 177,056 is referred to.

245,903.—Sulphuric acid.—Farbenfabriken vorm F. Bayer & Co., Leverkusen, Cologne, Germany.

Sulphur dioxide is oxidised to sulphuric acid in part by a contact process in which from one-sixth to one-tenth of the amount of catalyst ordinarily employed is used and the remaining sulphur dioxide is worked up by a chamber or other process. For the contact part of the process, besides platinum, catalysts such as iron oxide, spent pyrites and vanadium compounds in similar reduced quantities may be used.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25 Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

AGENTITE.

465,680.—Ammonium Salt for use in manufactures, photography, or philosophical Research. — Wallace & Tiernan Co., Inc., 1, Mill Street, Newark, New Jersey, U.S.A. March 3rd.

TONIOLITE.

466,202.—Electrolyte for electric accumlators.—Anthonie Jan Andre De La Ports, Schenkkade 80, The Hague. Holland. March 3rd.

BELMONTINE.

455,470.—Chemical substances prepared for use in medicine and pharmacy.—The Belmont Drug Co., Belmont Works, Havelock Road, Saltley, Birmingham. March 3rd.

" VEGANTOX."

465,507.—Chemical subtsances prepared for use in medicine and pharmacy.—Mercer Ward, Ltd., 302 to 308, Regent Street, London, W.1. March 3rd.

ENVAX.

465,563.—Chemical substances used in manufactures, photography or philosophical research and anticorrosives.—The Envarol Co., 89, Dawlish Road, Leyton, London, E.10. March 10th.

LYSOGEL.

464,255.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—The Union Chemical and Antiseptic Co., Kinnell, Greenbank Rd., Camelon, Falkirk, and J. J. Tweedie, Grange Croft, Bo'ness, West Lothian. March 10th.

HASBRON.

466,038.—Chemical substances prepared for use in medicine and pharmacy.—Brook, Parker & Co., Ltd., Ashfield, Horton Road, Bradford, Yorkshire. March 10th.

NOVOCYT.

466,199.—Chemical substances prepared for use in medicine and pharmacy.—Johann Abraham Von Wulfing, 231, Friedrichstrasse, Berlin, S.W., Germany. March 10th.

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Publisher's Announcements.

The following Books can be obtained from Rea and Inchbould, Merton House, Salisbury Square, London, E.C.4.

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THE CHEMICAL NEWS,

VOL. CXXXII. No. 3442.

MERTON HOUSE, SALISBURY SQUARE,
LONDON, E.C.4.
TELEPHONES :
Administrative : Central 6521.
Printing Works : Hop 2404.

COMPLEX COMPOUNDS OF BERYLLIUM WITH SODIUM BICARBONATE.

By A. BALANDIN (Moscow).

The beryllium ion shows a well defined tendency to form complex compounds owing to its small volume. In aqueous solutions it is hydrated in a high degree. On trying to isolate its compounds from aqueous solutions, very complicated compounds are usually obtained, and to which no definite structure in the sense of Werner's theory, can be ascribed[1].

For this reason, G. N. Lewis[2] suggested that these definite complex compounds should be studied in non-aqueous solutions, and, indeed, such compounds have been prepared in this way by Fricke[3] and his co-workers. Beryllium chloride combines with two molecules of ammonia, aniline, nitrobenzene aceto-nitrile, etc., without acquiring polar properties. In these cases, in accordance with Bragg's[4] X-ray analysis investigations and with the explanation of the structure based on that investigation over a wide group of basic compounds of the formula Be_4OAc_6—where Ac is the radical of an organic acid—gave the co-ordination number four for beryllium as was already done by Sidgwick[5].

In the presence of water the reaction between beryllium hydroxide and acid sodium carbonate, discovered by Parsons[6] is of great importance because it furnishes a simple method of separating beryllium from iron and aluminium. The mechanism of the dissolution of beryllium hydroxide in strong solutions of acid sodium carbonate has, however, not been studied till now. It seemed probable that some complex salts were formed in solution, and an investigation was therefore beguu to study them in solution, thereby avoiding their spontaneous decomposition at the time of isolation.

Pure beryllium hydroxide (prepared from Ural beryl), freshly precipitated with ammonia and washed until free from alkali, was shaken in constant amounts (excess) with a 1.08 normal solution of acid sodium carbonate at different temperatures in a thermostat. The general volume was 250 c.c. The liquid was analysed and kinetic curves (time—hydroxide dissolved) were obtained. The limiting values gave the solubility of beryllium hydroxide in sodium bicarbonate solutions as given in Table I.

TABLE I.

Temp.	21°	52°	55°	58°	65°	80°	90°
G. $Be(OH)_2$ per litre ...	21.7	23.9	18.5	16.7	15.8	16.3	0

These results are graphically reproduced in Fig. I.

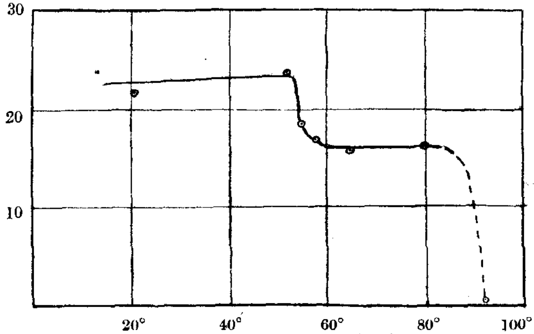

Fig. I.

Until a temperature of 80° is attained, no carbon dioxide is evolved. At 92° the liquid gradually loses all its beryllium hydroxide content and carbon dioxide escapes very rapidly. At 52° the atomic ratio of the content of Na : Be in the liquid *is equal to* 2, *at* 65° *it is equal to* 3.

The explanation of the obtained step-shaped curve can be made in the following manner.

Below 53° the reaction of combination of one molecule of beryllium hydroxide with two molecules of acid sodium carbonate takes place :

$$Be(OH)_2 + 2NaHCO_3 =$$

$$Be(OH)_2.2NaHCO_3 =$$

$$\left[\begin{array}{ccc} CO_3 & & OH \\ & Be & \\ CO_3 & & OH \end{array}\right] \begin{array}{c} Na_2 \\ H_2 \end{array} \qquad (I)$$

with formation of an acid sodium salt of the complex dihydroxidicarbonato-beryllium acid. This formula is in accordance with the observed facts, giving the atomic relation

$$\frac{Na}{Be} = 2$$

and giving the possibility of evolution of carbon dioxide on raising the temperature, because acid sodium carbonate is bound by co-valency forces. If one assumes that the reaction (I) goes further :

$$Be(OH)_2 + 2NaHCO_3 =$$

$$Na_2CO_3.BeCO_3 + H_2O \qquad (I_A)$$

(neutralisation) it would be difficult to understand how, at 92°, carbon dioxide is evolved. *Therefore, the reaction* (I_A) *is impossible.*

In the next step (at about 55°), the following reaction takes place :

$$\underset{A}{\left[\begin{array}{ccc} CO_3 & & OH \\ & Be & \\ CO_3 & & OH \end{array}\right] \begin{array}{c} H_2 \\ Na_2 \end{array}} = 2\underset{B}{\left[\begin{array}{ccc} CO_3 & & OH \\ & Be & \\ CO_3 & & OH \end{array}\right] \begin{array}{c} H \\ Na_3 \end{array}} + \underset{C}{\left[\begin{array}{ccc} CO_3 & & OH \\ & Be & \\ CO_3 & & OH \end{array}\right] H_4} \qquad (II)$$

The compound B remains in the solution, the compound C decomposes, giving off carbon dioxide, which is adsorbed by the excess of *beryllium hydroxide present in* thhe reaction-flask. Indeed, it is known that at not very high temperatures, beryllium hydroxide adsorbs about one-third of an equivalent of carbon dioxide[7].

At 92°, the next step is attained, the process is a complicated one :

$$4\underset{B}{\left[\begin{array}{ccc} CO_3 & & OH \\ & Be & \\ CO_3 & & OH \end{array}\right] \begin{array}{c} Na_3 \\ H \end{array}} = 3\underset{D}{\left[\begin{array}{ccc} CO_3 & & OH \\ & Be & \\ CO_3 & & OH \end{array}\right] Na_4} + \underset{C}{\left[\begin{array}{ccc} CO_3 & & OH \\ & Be & \\ CO_3 & & OH \end{array}\right] H_4} \qquad (III)$$

The complex compound C decomposes as previously, but now the carbon dioxide is not adsorbed by the beryllium hydroxide because of the high temperature; D is also an unstable compound (normal sodium carbonate does not combine with beryllium hydroxide) and also decomposes gradually, losing carbon dioxide and gives a precipitate of basic beryllium carbonate, which then decomposes further, giving beryllium hydroxide :

$$\left.\begin{array}{l} \left[\begin{array}{ccc} CO_3 & & OH \\ & Be & \\ CO_3 & & OH \end{array}\right] H_4 = Na_2CO_3 + Be(OH)_2 \\ \\ \left[\begin{array}{ccc} CO_3 & & OH \\ & Be & \\ CO_3 & & OH \end{array}\right] Na_4 = 2N_2O + 2CO_2 + Be(OH)_2 \end{array}\right\}$$

Thus all the hydroxide is precipitated and carbon dioxide is evolved in accordance with the experimental facts.

The described reactions are very similar to the reading of decomposition of acid sodium carbonate by heat :

$2NaHC_3O = Na_2CO_3 + H_2O + CO_2$,

but in the molecule of the acid sodium carbonate there is only one acid hydrogen atom present ,able to be replaced by a metal. In the assumed acid sodium salt A, there are two such hydrogen atoms, and thus the two steps of the diagram (Fig I.) are obtained.

Experiments especially made have shown that although the normal sodium carbonate does not react with beryllium hydroxide, its presence is not without influence on the equilibrium studied. Small quantities of that salt (below 4 per cent. of the content of the acid sodium carbonate) increase the solubility of beryllium hydroxide in the solution of acid sodium carbonate. Further addition of the normal carbonate has only a slight influence on the solubility, the quantity of dissolved hydroxide being not in relation with the quantity of normal carbonate added, as is to be seen from the following table, at 65° :—

TABLE II.

Millimol. per litre.			Ratio.
Na_2CO_3	$NaHCO_3$	BeO	$BeO/NaHCO_3$
41.7	1080	367	34.0
115	1010	361	34.8
187	951	333	35.0

This effect must be ascribed to the diminishing of the hydrolysis of the acid sodium carbonate in the presence of the normal salt. Therefore, in all the experiments described in Table I, an amount of 4.4% normal sodium carbonate (the percentage relates to the content of the acid salt), was added, but not taken into account in the calculations.

An attempt was made to isolate the assumed complex compound, formed at 45°. A saturated solution of beryllium hydroxide in the 1.08N solution of acid sodium carbonate (crystallised and containing no normal carbonate) has been made up, the excess of beryllium hydroxide filtered off and the solution treated with half a volume of ethyl alcohol. An oily layer was formed, which after cooling, gave a mass of little snow-white crystals. The liquid was filtered off also in cold. The precipitate washed with dry alcohol, which was then evaporated and gave 8.5 gr. of substance. The crystals melt at 8°, at room temperature they lose their alcohol content, and becomes a white powder, which immediately dissolves in cold water much easier than acid sodium carbonate itself. It is neutral in reaction to phenolphthalein and basic to methyl-orange. By boiling the water-solution, beryllium hydroxide precipitates, and the solution loses carbon dioxide. The solution of the isolated substance has a salt taste, which shows that the beryllium ion (which has a sweet taste), is not present.

ANALYSIS.

Found : Be = 4.83%, Na = 19.0%, residue after removing water and half-bound carbon dioxide (heating at 300°)- 59.9%

Calculated for $(CO_3)_2Be(OH)_2.H_2.Na_2$ is Be, 4.31% ; Na, 21.74% ; water, 62.10%.

The constitution of the isolated substance is very near to the complex compound assumed. The discrepancies between calculated and found values are probably due to the instability of the complex, which slightly decomposes during its isolation.

Thus the assumptions made on the basis of the solubility-curve receive confirmation from the analysis. The co-ordination-number of beryllium in the compounds found is four, in accordance with other observations.

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[1] T. S. Humpidge, *Proc. Roy. Soc.*, (London), 1896 XXXIX., 1.
H. Debray, *Ann de Chim. et de Phys.* (3), XLIV., 1.
Where the formulæ for complex beryllium carbonates $2[(NH)_2CO_3$, Be $CO_3]$.Be $(OH)_2$ $2H_2HO$ and 3Be CO_3 Be$(OH_2$ $3(NH_4)_2$ CO_3 are assumed.

[2] G. N. Lewis, *Valency*, 1923, p. 122.

[3] *Zeit. f. Anorg. Chemie*, 146, (1925), CIII. 121.

[4] *Nature*, April 31, 1923, p. 532.

[5] *Nature*, June 6, 1923, p. 808.

[6] Parsons and Barnes, *Amer. Ch. Soc.*, 1906, XXVIII., 1589.

[7] Parsons, *The Chemistry of Beryllium*, London, 1909, p. 28.

THE CHLORINE GAS TREATMENT FOR WATER.

By A Well-Known Engineer.

Very remarkable progress is now being made with the chlorine gas treatment for water, which is employed in four general ways, (1) sterilisation of town's water supply; (2) continuous treatment of swimming bath water; (3) disinfection of sewage and sewage effluents; and (4) addition to the cooling water of steam engines and turbines to prevent the formation of non-conductive slimy algoid and other organic growths on the condenser tubes, as well as deposits in cooling towers and similar plant and the growth of shell-fish in pipes when sea or brackish water is used.

The subject is, of course, a particularly interesting one from a chemical point of view, and generally about 1 part of chlorine per 2,000,000 parts of water is employed. Messrs. The Paterson Engineering Co., Ltd., of London, have just issued an extremely interesting publication, "Water Sterilisation by Gaseous Chlorine," which is really a complete handbook on the subject, and which, we understand, may be obtained free of charge from their address, Windsor House, Kingsway, W.C.2. It includes in the first place a general description of the process, especially from the historical point of view, and describes concisely the nature of the chemical reactions involved, with the intermediate formation of hypochlorous acid. There is also a detailed description of the Paterson "Chloronome" apparatus of two general types used for the continuous addition of the chlorine, depending on the volume of the water to be treated, the principle being, as is well-known, a panel arrangement of control and reducing valves, filters, metering equipment, and other accessories coupled up to cylinders of chlorine, together with a device to dissolve the chlorine gas in a small amount of water before adding to the main supply, ensuring in this way adequate mixing and uniform chlorination of the bulk volume of water, not otherwise easy to obtain.

Further, the book contains a special section dealing with the best general methods of application to suit all circumstances, and the many modifications possible, including entirely automatic control, and portable types of apparatus fixed on a motor vehicle, particularly valuable for quick disinfection of any given area. Also the interesting subject of super-chlorination followed by de-chlorination, is included, specially valuable for epidemics, generally cylinders of sulphurous acid gas being used to remove the excess chlorine, although a dilute solution of sodium sulphate, bisulphite and thiosulphate is almost equally suitable. Further, reference is made to the use of chloramine, NH_2Cl, formed by the action of chlorine on ammonia, discovered by S. Raschig and investigated principally by S. Rideal and J. Race, of considerable importance in the case of water possessing unusual oxygen absorbing properties, as apart from bacteria, chloramine not being affected under these conditions.

As regards the treatment of towns' water, this principle is now superseding the slow natural sterilisation by long storage in reservoirs, and for power station working the matter is of great importance, as it enables the highest vacuum to be maintained continuously at the turbine, a drop of only ¼″ corresponding, approximately, to 1% increased steam consumption. Altogether it is stated over 1,000 million gallons of water per day are now being treated by "Chloronomes" and the method is another striking example of the value of chemical principles applied to daily life.

X-RAY ANALYSIS OF SOME MIXED CRYSTALS OF THE SILVER HALIDES.

(R. B. Wilsey, *in the Journal of the Franklyn Institute.*)

As a result of equilibrium and potential measurements on mixed precipitates of the silver halides, Thiel concludes that silver iodide and silver bromide are able to form homogeneous mixtures with as high as 30 molecular per cent. of silver iodide; Trivelli and Sheppard also found that silver iodide formed homogeneous mixtures with silver bromide. The mixed crystals exhibited double refraction, whereas crystals of pure silver bromide did not. This fact led Trivelli to consider that the additional speed obtainable in photographic emulsions of silver bromide containing small amounts of silver iodide might be associated with a state of strain set up by the presence of silver iodide incorporated in the silver bromide lattice; the strain was caused by a distortion or stretching of the silver bromide lattice by the included silver iodide.

The powdered crystal method of Hull

was used. A survey was made of the structures of mixtures varying from pure silver bromide to pure silver iodide. Most of the mixtures were prepared by fusion; in one set the samples were cooled suddenly by quenching in water, and in another set the samples were allowed to cool more slowly by standing in the room; accurate control of the rate of cooling was not attempted. A few samples, containing up to 30 molecular per cent. of silver iodide, were prepared by precipitation, by adding silver nitrate to a mixed solution of potassium bromide and potassium iodide.

Mixed crystals of silver chloride with silver bromide, and silver bromide with silver iodide, in various proportions of the components, were examined by the X-ray powder method of crystal structure analysis. The AgCl-AgBr mixtures showed the simple cubic structure (NaCl type) characteristic of the pure components, with a lattice spacing lying between those of the two components and following a linear relation with the molecular concentration of each component.

Most of the AgBr-AgI mixtures showed the existence of two mixed crystals, one the simple cubic characteristic of pure silver bromide, but with an enlarged lattice spacing, and the other the diamond cubic or hexagonal type of the silver iodide crystal, with a slightly diminished lattice constant. In mixtures up to and including 70 molecular per cent. of silver iodide, the simple cubic structure predominated, its lattice spacing increasing with the percentage of silver iodide fused in the mixture. silver iodide appears to go into the silver bromide lattice quite readily, the calculations indicating that the largest simple cubic structure observed contained as much iodine as bromide; while judging by the effect upon the lattice constant of the silver iodide structure, very little silver bromide entered the silver iodide lattice.

General Notes.

BRITISH INDUSTRIES FAIR, 1927.

In view of the conspicuous success achieved by the British Industries Fair held last month in London and Birmingham, it has been definitely decided to hold the Fair again next year at approximately the same time.

The Government grant for publicity purposes overseas and at home undoubtedly contributed in no small degree to the satisfactory results of the recent Fair, and the President of the Board of Trade has announced the Government's intention to make a similar grant in connection with the next Fair.

COMMITTEE ON INDUSTRY AND TRADE.

It will be remembered that the Committee on Industry and Trade, of which Sir Arthur Balfour ,K.B.E., is chairman, was appointed by the Prime Minister to investigate the position and prospects of British Industry and Commerce, and the Committee published last July a "Survey of Overseas Markets," dealing with one aspect of their terms of reference. The Committee have now prepared a second volume under the title "Survey of Industrial Relations," which deals with the growth of the population, wages, hours, and other conditions of labour, unemployment, and the machinery for dealing with industrial disputes. The volume also includes certain material on the position in other countries as regards some of these subjects, *e.g.*, hours of labour and negotiating machinery. The contents of the volume are mainly derived from official sources, and the Committee have prefixed an introduction calling attention to certain important considerations arising from the survey. It is hoped that the volume will be of considerable service, both as a permanent work of reference and also at the present juncture when public attention has been focussed upon industrial relations and conditions in various industries. The volume will be published by H.M. Stationery Office.

TWENTY YEARS WORKING OF THE ELECTROLYTIC DISINFECTING PLANT OF POPLAR (LONDON).

The Medical Officer of Health of Poplar, Dr. Frederick W. Alexander, has issued an interesting report under the above title. In it he recounts the early difficulties and active opposition with which his ambitious scheme to protect the health of the inhabitants was confronted. His perseverance and optimism have been amply rewarded in the success of his scheme, as reflected in the bealth of this notoriously poor borough.

None but a man of stern will and deep conviction could have fought the opposition (which was apparently not always disinterested) to victory. When Dr. Alexander thought he had won the fight, he was confronted with an action for injunction. He says that "when almost at my wit's end, a happy thought struck me. I obtained two chemicals, placed them in separate carboys, allowed the fluid to fill these vessels, handed the results to Mr. A. E. Parkes, who is now the Borough's Public Analyst, and upon his analyses I worked out upon a bed-rock basis the manufacture of electrically produced fluid containing hypochlorites and the rationale and chemistry of the process for securing stability. I wrote an article and handed it to the late Mr. Vasey, Chemist to the *Lancet*, and it was published in full in that journal. The process was patented, and, curious to say, at the Patent Office there are various Patents relating to the stability of Hypochlorites—hence the threatened injunction—but the substance I used had not been included owing no doubt to its difficult nature in handling, therefore, my happy thought brought success to the undertaking, and proved simplicity itself.

Hypochlorite of magnesium belongs to the magnesia and not to the alkali group. It is not caustic, is non-poisonous, and to the clothes is the least destructive of all the hypochlorites. It is obvious that the stable solutions of electrolytically-made hypochlorites of magnesium are preferable to those of sodium and potassium or even calcium, because for the purposes of rendering the three last mentioned solutions stable there would have to be used hydroxide of the metals of the alkali or the alkaline earth calcium, which are extremely caustic, alkaline, and very soluble, and where varying strengths of electrolytic fluid, containing the hypochlorites of sodium and potassium, are produced, one may add too much or too little of the hydroxides of the alkalies when working with unskilled labour. But when the extremely insoluble hydroxide or oxide of magnesium is added and mixed, one can add and stir in any quantity, but only the necessary amount will be absorbed.

In the addenda to the report, Dr. Alexander gives a good deal of interesting information on disinfectants, etc., and hints at impending severance of his connection with the Borough, of which he has been such a steadfast friend and pioneer in the cause of sanitation and public health.

Excerpt from the addenda :—

"Caustic soda or hydrate of sodium solution used at the depôt is 192 lbs. of 70% hydrate of sodium to 48 gallons of water. It has been calculated that 7½ fluid ounces of this solution are sufficient to stabilise 7¾ gallons of the electrolysed fluid produced in each cell of the new plant, or in round figures, one fluid ounce per gallon. The resultant electrolysed fluid contains 10 grammes of chlorine per litre and it is diluted to half that strength, after the caustic soda solution is added and stirred in.

When making hypochlorite of magnesium 600 c.c. of a saturated solution of chloride of magnesium with 600 c.c. of the caustic soda solution are mixed together, forming a gelatinous mass which is broken up and diluted with a little water. This is added to the water in the top tank which is kept stirred during manufacture, in order to have a solution with an evenly distributed stabiliser running through the electrolysers.

The hydrate of magnesium to stabilise the fluid in the carboys consists of 300 c.c. of a saturated solution of chloride of magnesium, and 400 c.c. of caustic soda solution added together and treated in similar manner to the above and then stirred into the contents of the carboys. As previously mentioned, this is extremely insoluble, and falls to the bottom after it has neutralised or fixed the acid. As already explained, it is not necessary to use these two mixtures, for hydrate of magnesium can be formed in the top tank or in the resultant electrolytic fluid by simply adding caustic soda—no doubt a cheaper and better method—when the white precipitate of hydrate of magnesium is formed."

UNIVERSITY OF READING.

In 1892 a college was founded at Reading, the well-known biscuit manufacturing town with a population of 93,000.

On Saturday, March 20, a Royal Charter was received creating it a University. It has a capacity for 1,000 full-time students.

The following are the dates of the Charters of the modern English Universities.—

Durham	1832
London	1836
Manchester	1850
Birmingham	1900
Liverpool	1903
Leeds	1904
Sheffield	1905
Bristol	1909
Reading	1926

"FLOWERS OF SULPHUR."

Chemical News readers will remember that we recently published a report of the Court proceedings in which a well-known firm was fined for selling under the name "Flowers of Sulphur," sulphur prepared otherwise than by subliming. The firm determined to appeal. We have now received the following statement from the London Chamber of Commerce :—

"In order to avoid misconception, the London Chamber of Commerce has issued the following statement regarding the recent prosecution under the Merchandise Marks Act, 1887, relative to the trade use of the description 'Flowers of Sulphur.'

At the outset unquestionably the term was applied to sublimed sulphur.

Some years ago it was found possible to produce, by other processes ,a sulphur composed of particles of a purity and fineness equal to sublimed sulphur. The new product, for this reason, was sold by some manufacturers and merchants as 'Flowers of Sulphur.'

Whether the expression 'Flowers' implied the product of sublimation or highly refined sulphur of a similar fineness of particle became a question, there being considerable difference of opinion in the trade.

So far as the largest market for finely divided sulphur, the Rubber Industry, was concerned, the point was of no importance, but in the hopfields sublimed sulphur had been in general use as the specific against the disease known as hop 'mould.'

In these circumstances, the London Chamber of Commerce was urged to take legal action in order that the precise meaning of the trade term 'Flowers of Sulphur' might be finally settled by the Courts.

The jury found that 'Flowers' could only be applied to sublimed sulphur.

The Chamber is anxious to make it clear that this result does not imply any reflection upon those manufacturers and merchants who have been in the habit, for years, of applying the word 'Flowers' to a sulphur which was not, in fact ,sublimed. It desires, therefore, to state categorically that whilst the trade was divided in opinion, all parties acted in perfect good faith, and the attitude of the Chamber in the matter having now been explained, the trade interests concerned have abandoned their intention to proceed with the appeal which had been lodged. In the circumstances, the Chamber of Commerce is meeting the defence in the matter of costs.

PROCEEDINGS AND NOTICES OF SOCIETIES.

AUSTRALIAN INSTITUTE OF MINING AND METALLURGY.

In August, fifty-two members and students visited Broken Hill, the great mining centre (combining business with pleasure). Mr. E. G. Andrews, Government Geologist of New South Wales, delivered a lecture at the Technical College on "The General Geology of Broken Hill."

BRIEF ABSTRACT.

He said :— "All rocks may be divided into two types, namely, rocks which have been formed at the surface of the earth, and rocks which hvae not been formed at the surface of the earth. Examples of the first type comprise beach sands, the alluvium of the central plains of New South Wales and Queensland, the Victorian basalts, and the Sydney (N.S.W.) shales and sandstone. Examples of the second type are those of the Broken Hill series, while an intermediate group is made up of the rocks of the Torrowangee (Broken Hill) series, the Adelaide series, the slates and sandstones of Melbourne, the lignite or brown coal of Morwell (Victoria), the black coals of Australia, the limestones and marbles of the Australian States, the "chalk" of Europe, the Devonian quartzites, the Cobar slates, and many others. The stndy of the rocks of the second type at Broken Hill is particularly difficult. These rocks have suffered intense chemical alteration, and such types have received only scant attention from Australian geologists. They have been formed deep down below the surface, miles down in the cores of Himalayan or Alpine ranges.

GEOLOGICAL HISTORY OF BROKEN HILL.

In attempting to reconstruct the conditions under which the Broken Hill rocks were formed, let us forget Broken Hill as we see it to-day. Let us rather see before us a long geosyncline, or structural basin, occupied by a shallow sea, and bordered or flanked by a great Himalayan range. This range is gradually denuded and the waste thence carried by the streams into the basin of geosyncline, which keeps sinking as its load increases. This waste is laid down in thin layers of mud, shale, sand and pudding stone. The floor of this basin has its limiting strength, however, and, when it can no longer sustain its evergrowing load, it yields; its sides come in; and the whole mass then is uplifted to form a mighty range like the Himalayas of to-day.

As the floor of the basin or geosyncline yields, the thin layers of mud, shale, and sand, were bent towards each other. Many volcanoes burst upon the flanks of the rising ranges. No sign of these exists to-day, however, owing to the enormous erosion or denudation to which the area has been subjected.

It is almost certain that volcanic rocks were common over the Broken Hill area during this rise of the old sea floor, but the only rocks which we see exposed to-day at Broken Hill proper are those which were given their present forms under conditions of abyssal burial; in other words, those rocks which may be expected to occupy the core of a mighty mountain range.

The igneous or fire rocks of Broken Hill appear to have pushed their way between the sediments at a great depth below the surface and under an enormous head, a head so great that they were enabled to force the schists apart even under the enormous load weighting them down. Two points of marked contrast with the more superficial types are at once noticeable. In the first place the forms of the two types are markedly different. The 'pressure lens' or elongated sil, and the 'phacolite' are noticeable at Broken Hill. The 'lit-par-lit' structure also is prominent, as though the molten rock had been injected or forced as tiny lenticles between the bedding planes to form sandwich structures. These pressure lenses are discontinuously continuous, that is, they may be discontinuous as individuals (Footwall Gneiss), but they appear to emanate from a common source, and to be arranged along a common zone of structural weakness. Excellent examples of these lenses and 'phacolites' occur in the Footwall and Augen Gneiss, the pegmatites, the 'diorites,' and the igneous quartz lenses. The section across the Broken Hill area illustrates this. Other examples are the granites of the area a few miles distant from the Broken Hill lode proper, as also the serpentone 'phacolites' and lenticular sills. Some of the western granites have blunt apophyses, as though the load above them were not so great as in the case of the intrusives of the central area.

Another marked peculiarity in these lenticular igneous rocks is their gneissic or banded appearance. Thus in the central area, at and near the Broken Hill lode, as also at the Pinnacles (ten miles to the S.W.), the igneous rocks occur as 'primary' gneisses, that is, their remarkable bandings are parallel or subparallel to the bedding planes of the altered sediments between which they have been developed. Magnificent examples of these types are to be seen in the granitoid gneisses of the Footwall, the Augen Gneiss of Stephens' creek, and on both sides of the main lode. The 'diorites' also exhibit this feature well. The outer granitic, pegmatitic, and serpentinous lenses and 'phacolites' do not exhibit it in so marked a manner.

Another point of interest is the peculiar association of light and dark rocks during this intrusive period. 'Diorites,' siliceous granitic gneisses and pegmatites are in intimate association. The 'Quartzites' are a peculiar group of rocks containing a very high silica percentage, and upon which there is no consensus of opinion. Drs. W. R. Browne and C. E. Tilley, and Mr. G. W. Card, consider them to be igneous. Dr. F. L. Stillwell considers them to be altered sediments. They are well shown at certain places, as in the western open cuts on the western fall, Block 14, and on Hospital Hill, especially in Bromide Street between Thomas and Morgan Streets. The field-evidence generally suggests that they are altered sediments.

After the main intrusions of these lenticular and 'bedded' gneisses, 'diorites,' lit-par-lit pegmatites, the granites, and the serpentines, the close folding of the rocks commenced properly. Sediments and igneous rocks suffered alike, and an intense chemical alteration of the sediments was

set up. In this folding which affected the Broken Hill sediments and intrusives alike, two points of special interest may be noted, namely, the peculiar nature of the typical folds, and of the new minerals developed.

Development of Minerals.—During the close folding of the Broken Hill area minerals were developed within the old mudstones, shales, sandstones, and the igneous intrusives. The development of minerals was differential and fading away, generally, as from a centre of maximum alteration. The centre was at Broken Hill, where garnets, mica, sillimanite, and other minerals were developed along the new planes of pressure, cleavage ,or schistosity in the sediments. These new minerals were heavy and dense as though they had arranged it designedly, taking up less space so as to escape the heavy pressure. The longer axes of the minerals are parallel to the planes of schistosity. Along zones of strain or crush, staurolite and white mica were commonly developed.

Ten to fifteen miles distant, however, from Broken Hill as a centre, the development of these dense new minerals was not nearly so marked; in other words, the ancient mudstones, shales, and sandstones in this outlying district suffered much less alteration than at Broken Hill itself. It is a fact of observation that increasing intensity of chemical alteration in Broken Hill is marked by progressive coarseness of texture or size in the secondary minerals developed. Examples of this are to be found in the coarse sillimanite schists of Broken Hill and the mica slates and schists twenty to fifty miles to the north in rocks of the same age and originally of the same mudstone and fine shales.

Post Broken Hill Lode History.

It remains to be seen what happened to this area which had been so closely folded and altered. After the formation of the lodes the great mountain range was denuded. The rising was repeated several times, but complete denudation was the ultimate fate of the ranges. The volcanoes and the granites of the upper portions of the crust were worn away, and the schists, gneisses, and ore deposits, which had been formed within the core of the range, were exposed finally at the surface itself. At a late stage in this rising and denudation, a network of dykes of a dark-coloured rock intersected the country, as may be seen remarkably well a few miles to the west and north-west of Broken Hill township.

The activities enumerated here are referred generally to the Archæan period, certainly well down in the Pre-Cambrian.

Long afterwards when the surface rocks had been removed by denudation; when the rocks and ore deposits of the abyssal chemical laboratories of the crust had been exposed at the surface, the land again sank and was covered by an ice sheet. The debris from this Glacial period has left great thicknesses of tillite, of boulder erratics, and related rocks, together with lenticular limestones, mudstones, and shales. Erratics of the old Archæan basement, containing also large fragments of the magnetite lodes from 'the Sisters,' are to be found twenty miles to the north of Broken Hill.

In proposing the toast of 'The Mining Industry,' Mr. E. C. Andrews said that Australia had in the past produced £1,100,000,000 worth of metal. Broken Hill had contributed about one-eighth of that, or £130,000,000, or enough, if coined in silver, to put a row of shillings around the globe. In 1851 the gold industry put Australia on the may. Victoria has produced £302,000,000 worth of gold, New South Wales £64,000,000, the Northern Territory and South Australia about £4,000,000, West Australia £155,000,000, and the rest divided between Queensland, 83,000,000, and Tasmania. Copper has produced £92,000,000; tin £41,500,000; iron, £11,000,000; silver, lead, and zinc, £132,000,000; and coal, £155,000,000. Because copper is now being produced at a greater cost that it is worth, and because tin stocks are being sadly depleted, and because the iron and oil reserves are not as great as they are in other countries, and because the gold is beginning to peter out, were they to become faint-hearted? They should look farther forward and see what is necessary to conserve the forces. First, they had Broken Hill, which meant silver, lead, zinc, cadmium, and sulphur, and 18,000,000 tons as ore reserves, and probably 7,000,000 tons more. When they went south of the present workings of the Zinc Corporation and north of the North mine, the lode would probably show great additions beyond those present known limits. At the present value of minerals

these reserves were valued at £1,000,000. They must not consider that as actual dividends, as the dividends amount only to about one-fifth of the gross production."

MINERALOGICAL SOCIETY.

The following papers were read at the meeting held on March 16, Prof. W. W. Watts, President, in the chair :—

On Molecular Volume Relations in the Mica Group. By A. F. HALLIMOND.

The "observed" molecular volume is obtained from the density and silica-percentage, on the assumption that the mica molecule contains the same number of silicon atoms for all members of the group. It is shown that the molecular volumes so obtained are of similar dimensions throughout, but that each of the non-miscible sections, muscovite, lepidolite, etc., has a distinctive molecular volume, in agreement with the chemical classification proposed in earlier papers. The volume is an additive property, and can be expressed as the sum of the volumes of the oxides present. The corresponding absolute molecular volumes for the oxides are in general agreement with those derived from X-ray measurements. Micas deficient in potash do not show a corresponding diminution of volume. Titanium is usually present as TiO_2, but two titanium-rich biotites only give normal molecular volumes when represented as compounds of Ti_2O_3.

Smithsonite from the Rhodesia Broken Hill Mines. By E. D. MOUNTAIN.

Colourless crystals, 7mm. in size, in the British Museum (Natural History), are of the form f(111), striated parallel to longer diagonal. Cleavage angle rr′ = 72° 21′. H = 4-4½. G = 4.398. Contains 97.34% $ZnCO_3$. Refractive indices measured on oriented prisms gave for Va-light ϵ = 1.6212 ω = 1.8485.

The Identity of the Cobija and Lampa Meteoric Stones. By E. D. MOUNTAIN.

A complete quantitative analysis of Cobija and a partial analysis of Lampa confirm Dr. Prior's suggestion of their identity; f = 14; n = 10½; m = 5 (Prior's nomenclature). Specific gravity 3.58. Further evidence suggests that they are two stones of the Cobija fall.

On Garnet in Pelitic Contact Zones. By C. E. TILLEY.

In the normal pelitic contact zone, garent is inconstant in its occurrence, and from many aureoles is entirely absent. The instability of almandine in normal thermal metamorphism is attented by the destruction of this mineral when crystalline schists containing it are involved in the aureoles of the Caledonian granites of Scotland. Aureoles especially conspicuous for the presence of garnet are those of New Galloway, Co. Wicklow, and Skiddaw. Analyses of garnets from these show considerable spessartine percentages, varying from forty to fourteen. The occurrence of garnet in pelitic contact zones (stress zones excluded) appears to be conditioned by the presence of a considerable MnO content, promoting the formation of spessartine bearing types. Almandine proper is characteristically a stress or high pressure mineral; the physical conditions for its formation are not realised in normal thermal aureoles.

GEOLOGICAL SOCIETY OF LONDON.

The Annual General Meeting was held on February 19, 1926, Dr. John William Evans, C.B.E., F.R.S., President, in the Chair.

The Reports of the Council and the Library Committee, proofs of which had been previously distributed to the Fellows, were read. It was stated that, of the 52 Fellows elected in 1925 (1 less than in 1924), 35 paid their admission fees before the end of that year, making, with 10 previously elected Fellows and 1 reinstated Fellow, a total accession of 46 in the course of 1925. During the same period, the losses by death, resignation and removal amounted to 59, and there was thus a decrease of 13 in the number of Fellows (as compared with an increase of 4 in 1924).

The Receipts of the year, including the interest on the Sorby and Hudleston Bequests and £200 transferred from the Voluntary Publication Fund, amounted to £4,378 5s. 5d., and the Expenditure to £4,051 0s. 8d. The year opened with a balance in hand of £377 6s. 5d.

The Reports having been received, the President handed the Wollaston Medal (awarded to Prof. Henry Fairfield Osborn) to Mr. Boylston A. Beal, Councillor of the Embassy of the United States of America, for transmission to the recipient.

The President presented the Murchison Medal to Prof. William S. Boulton.

The President presented the Lyell Medal to Prof. Owen Thomas Jones.

The President then proceeded to deliver his Anniversary Address, dealing with the subject of Regions of Compression. He said that the characteristic structures of regions of compression—that is to say: folding, thrust-faulting and slaty cleavage —are, as a rule, the result of horizontal forces ultimately to be attributed to the contraction of the Earth's interior as it cools. It has been doubted whether, with the energy released by radioactive elements, the Earth cools at all. It is certain, however, that the whole of that energy is not converted into heat; much must be employed in effecting phyiscal, chemical, or atomic changes in the surrounding rock. The substance of the ionised pleochroic haloes in biotite-mica is hundreds of thousands of times greater than the radioactive material in the zircon round which they are formed, and they must represent a relatively enormous absorption of energy.

Dr. H. Jeffreys shows that the contraction on cooling of the crystallised rocks is more than enough to account for the folding of existing mountains. But there are many folds of ancient mountains, now worn down, which would require still more contraction. This may have occurred in the following ways: (1) the contraction of uncrystallised magma retaining the volatile constituents is greater than that of crystallised rocks; (2) the contraction on crystallisation is equal to that on a fall of temperature of very many degrees; (3) contraction may take place on changes of crystal-structure, chemical composition, or even atomic nature; (4) contraction will result from the loss of volatile constituents; (5) it must also follow on the increase of pressure in the Earth's interior due to the slowing-down of its rotation. On the other hand, the extent of the crust may be locally increased in bands of tension by (1) infilling of rifts by igneous intrusions, and (2) slip-faulting; and also by hydration of rocks.

Compression and folding may also result (1) from change in the Earth's form on diminished rotation; (2) from change in the position of the crust relatively to (*a*) the poles and equator, (*b*) the maximum of gravitational force.

In illustration of the process of folding, two examples are described: (1) the 'Hercynian,' or 'Armorican,' folding of the south-western peninsula of England and South Wales; and (2) the Wealden folding between the Thames Valley and the 'Massif Central' of France. In the former case it is shown that the accumulations of sediments from mountains formed by Caledonian movements resulted in a 'sedimentation-subsidence.' This was slightly contracted and deepened by early Hercynian compression. This 'compression-subsidence' allowed still greater Hercynian accumulations of sediments. The oncoming of the main Hercynian compression contracted much more vigorously the basin of subsidence, forcing up the contained sediment into folds. The accumulated weight of these gave rise to a deep 'folding-subsidence.' A distinction is made between the exterior structure formed from the old floor of deposition and the interior structure consisting of the sediments deposited on it. The outflow of the plastic 'sima' from below the deepened basin raised its southern rim, with the result that in the course of the compression the folds were tilted northwards and dipped southwards. The folds are defined by the calcareous and arenaceous banding, while the argillaceous material between flowed rather than folded; and it is this flow which is now represented by slaty cleavage. In a later stage, both outer and inner structures were traversed by thrusts, which, like the folds and cleavage, dipped southwards. The greatest of these thrusts brought, in the extreme south, the pre-Cambrian rocks up against the Palæozoic. In the south of Devon and Cornwall this and other thrusts drove older rocks over new; but in North Devon new were brought over old. The displacement of the 'sima' in the course of mountain-building resulted in the intrusion of basic magmas, while the granites were probably derived from a reservoir beneath the uplifted pre-Cambrian rocks on the south.

The Wealden folding had its origin in sedimentary accumulations in a vast Triassic plain paved with the eroded outcrops of older rocks, and bordered by Hercynian highlands. The sedimentation-subsidence was widespread, and the compression in late Secondary and Tertiary times deepened it considerably, so that its floor has never been reached by borings south of the northern slope of the Wealden anticline, except in the neighbourhood of the Massif Central and the Hercynian tracts on the east and west. The actual compression in

this region was small compared with that which occurred about the same time in the Pyrenees and in the Alps, but it threw the sediments of the interior structure into numerous folds.

The Ballot for the Council and Officers was taken, and the following were declared duly elected for the ensuing year:—

Council—Dr. Arthur Francis Bather, M.A., F.R.S.; Prof. Arthur Hubert Cox, D.Sc., Ph.D.; Thomas Crook; Henry Dewey; Dr. James Archibald Douglas, M.A.; Gertrude Lilian Elles, M.B.E., D.Sc.; Dr. John William Evans, C.B.E., LL.B.. F.R.S.; Prof. William George Fearnsides, M.A.; Prof. Edmund Johnston Garwood, M.A., Sc.D., F.R.S.; Prof. William Thomas Gordon, M.A., D.Sc., F.R.S.E.; Dr. Edward Greenly; Prof. Herbert Leader Hawkins, D.Sc.; Robert Stansfield Herries, M.A.; Sir Thomas Henry Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S.; Dr. Finlay Lorimer Kitchin, M.A.; Prof. John Edward Marr, M.A., Sc.D., F.R.S.; Horace Woollaston Monckton, Treas.L.S.: Tressilian Charles Nicholas, O.B.E., M.C., M.A.; John Pringle; Walter Campbell Smith, M.C., M.A.; Leonard James Spencer, M.A., Sc.D.; Arthur Elijah Trueman, D.Sc.; and Sir Arthur Smith Woodward, LL.D., F.R.S., F.L.S.

Officers—*President*, Dr. Francis Arthur Bather, M.A., F.R.S.; *Vice-Presidents*, Dr. John William Evans, C.B.E., LL.B., F.R.S.; Sir Thomas Henry Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S.; Horace Woollaston Monckton, Treas.L.S.; and Sir Arthur Smith Woodward, LL.D., F.R.S., F.L.S.; *Secretaries*, Walter Campbell Smith, M.C., M.A., and Dr. James Archibald Douglas, M.A.; *Foreign Secretary*, Prof. John Edward Marr, M.A., Sc.D., F.R.S.; and *Treasurer*, Robert Stansfield Herries, M.A.

The thanks of the Fellows were unanimously voted to Dr. J. W. Evans, retiring from the office of President; to Sir John Smith Flett and Prof. A. C. Seward, retiring from the office of Vice-resident (and also from the Council); and to the other retiring Members of Council; Prof. P. G. H. Boswell, Dr. W. D. Lang, and Mr. H. Woods.

NOTICES OF BOOKS.

Die Photographisch-Chemische Industrie, von Dr. F. Wentzel. Pp. XVI + 364. Dresden and Leipzig: Verlag von T. Steinkopff, 1926. Price 18.50 marks.

This volume in the *Technische Fortschrittsberichte* edited by Prof. Rassow and published by Theodor Steinkopff, deals with the chemistry of all the processes connected with photography and photographic materials, and indicates the development since 1913.

The work commences with the cleaning and preparing of glass for the dry plate, and deals exhaustively with the preparation and ripening of silver haloid emulsions and their transfer to the plates; the preparation of plates for special purposes; testing and grading of the plates; measurements of speed and sensitivity; preparation and examination of photographic and kinematographic films; preparation of photographic papers, including the pretreatment of the paper base; analysis of photographic materials; development; fixing; intensifying; reduction; toning, valuation of residues, *e.g.*, waste emulsions, fixing and toning baths.

Each section is treated fully, and in general leaves little to be desired although the author states in the preface that it has not been possible for him to consult some important journals published outside his own country.

In his account of developers he gives a table showing the keeping properties of the solutions. Thus, amidol developers last only 17 hours, whilst metol keeps for 20 days. He refers to the stabilisers used in preserving developer solutions and gives a number of aliphatic acids used in stabilising amidol, but is apparently unacquainted with a paper by the reviewer (*British Journal of Photography*, 1922, LXIX., 81) in which it was pointed out that amidol containing a trace of the double tin salt was its own stabiliser.

The account of toning processes omits any reference to toning with tin salts. Alkaline stannite solutions yield a variety of pleasant brown tones with bleached bromide prints. This has apparently escaped the attention of Dr. Wentzel.

In the section on intensifying and reduction, mention is made of the interaction of ammonia on mercury haloids. This has since been exhaustively studied by two of

his own countrymen, but as the account of it appeared in a purely scientific journal (*Zeitschr. fur anorg. Chem.*), it seems to have remained unnoticed by the author. Most of his references appear to have been culled from the weekly *Photographische Industrie.*

The volume should prove of great value to those interested in the scientific and industrial aspects of photography.

J. G. F. D.

Metallic Packing. By J. N. Walton.

Metallic Packing is the title of a book of 140 pages (5th edition), by J. N. Walton, issued by The Crane Packing, Limited, of Slough.

It is intended to acquaint engineers more fully with the latest methods of surmounting packing problems. It is pointed out that the use of frictional substances for packing is inconsistent with sound engineering practice. Most difficult packing problems have been solved by the use of the metallic seal. This is the only means of permanently reducing friction, power losses, wearing and fluting of rods, shafts and plungers and other troublesome features common to machinery on which fabric packing is used.

The book not only covers ordinary packing requirements but also deals with many special packing problems, which have been solved only by the most careful study and painstaking experimental work.

The Geological Age of the Earth. Being the twenty-seventh Robert Boyle Lecture, delivered before the Junior Scientific Society of Oxford, on June 6, 1925, by John Joly, D.Sc., F.R.S., Fellow of Trinity College Dublin. Humphrey Miller, Oxford University Press.

Prof. Joly's standing as a scientific man is a guarantee that any lecture delivered by him or any book from his pen is worthy of attention. The present lecture, which contains some useful diagrams, and is well produced, as are all the Oxford University Press publications, contains carefully marshalled data in support of the statements advanced. The lecturer assumes from the probable time required for the deposition by the ancient ocean, of the archaean sediments in North America, comprising the oldest known rocks, that the age of the ocean is 100 to 175 million years. By the lead ratio method, he reasons that certain silurian or ardovician materials must have been *in situ* for 430 millions of years, that certain Huronian minerals must possess an age of 1,200 million years, and that archaean minerals were formed 1,640 millions of years ago. He reminds his readers that he is not discussing the age of the earth as a planet, but its age since oceanic conditions have prevailed upon its surface. In the geological history of the earth " there must have been large periods of denudation, during which sediments have accumulated in vast (ocean) hollows. During this period the continental surface slowly sank, as the sediments collected, while shallow continental seas spread over the subsiding land. This period lasted many millions of years. Then the continental areas again rose, the reas retreated, the mountains began to arise where the sedimentary accumulations had taken place. Many millions of years were consumed in perfecting these changes. Four or more of these geological revolutions are recognised as having taken place, representing 160 to 240 millions of years." He points out that the progress of one complete cycle of terrestrial history may be considered as divided over two great time intervals, and the duration of one of these is defined by the period required for the accumulation of sufficient radioactive heat in the denser substratum upon which the continents isostically float, to bring about the liquefaction of that sub-stratum and attendant sinking of continents.

RECENTLY- ISSUED OFFICIAL AND OTHER PUBLICATIONS RECEIVED.

International Review of the Science and Practice of Agriculture. (Rome.)

Year Book of the Michigan College of Mines.

The Physical Society of London, and the Optical Society. Sixteenth Annual Exhibition.

Alternating Current Distribution in Cylindrical Conductors. U.S.A. Bureau of Standards.

Dielectric Constant, Power Factor and Resistivity of Rubber and Gutta Percha. U.S.A. Bureau of Standards.

Proceedings of the Engineers' Society of Western Pennsylvania.

Temperature Estimates of the Planets of Mars. U.S.A. Bureau of Standards.

FORTHCOMING EVENTS

PHYSICAL SOCIETY OF LONDON.

The Optical Convention, 1926, will take place from April 12 to 17, 1926, at the Imperial College of Science and Technology, Imperial Institute Road, South Kensington, S.W.7. The activities will include :—

Lectures and Papers.—An address by the President, Sir Frank Dyson, M.A., LL.D., F.R.S., special lectures by Professor A. S. Eddington, Professor G. Elliot Smith and others, and a large number of Papers of interest in all branches of optical science.

Exhibits.—The Exhibition will include research and experimental apparatus, historical instruments, and exhibits by a large number of British manufacturers.

Entertainments.—A special section, free to members, including dramatic performances by students of the Royal Academy of Dramatic Art, is being arranged by Sir Richard Paget and Dr. R. S. Clay. It will comprise optical illusions and stage effects produced by optical devices.

THE OPTICAL SOCIETY.

THE OPTICAL CONVENTION, 1926.

The Optical Convention will be held at the Imperial College of Science and Technology, during the week April 12 to 17, inclusive.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

The next meeting of the Society will be held on Wednesday, April 7, at the Chemical Society's Rooms, Burlington House, Piccadilly, W.1., at 8 p.m.

The following papers will be read :—

" The Analysis of Acetic Anhydride," by H. Droop Richmond, F.I.C., and J. A. Eggleston, B.Sc.

" The Analysis of Glacial Acetic Acid," by H. Droop Richmond, F.I.C., and E. H. England.

(i) " Errors of Personal Judgment in Chemical Work." (ii) " Results of Further Work on Variations in the Composition of Milk," by J. F. Tocher, D.Sc., F.I.C.

" A Test for Tung Oil," by E. Richards Bolton, F.I.C., aud K. A. Williams, B.Sc., A.I.C.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

6,713.—Aarts, C. J. G.—Condensation of zinc vapours. March 10th.

6,698.—Bull, P.C.—Production of white synthetic resins. March 10th. .

6,451.—Grasselli Chemical Co.—Aldehyde amine condensation products, etc. March 8th.

7,052.—I. G. Farbenindustrie Akt Ges.—Production of aromatic derivatives of formamide. March 13th.

6,977.—Smith, P. A.—Production of acid amines and salts. March 13th.

Abstract Published.

246,177.—Cyanides; ammonia.—Gewerkschaft Sachsen-Weimar, Unterbreizbach-on-Rhone, Germany. January 18, 1926. No. 1439. Convention date, January 17, 1925. Not yet accepted. Abridged as open to inspection under Section 91 of the Act. (Class 1 (ii).)

Cyanides are produced, together with some ammonia, by the reaction of nitrogen alone or in admixture with other gases, such as producer gas, upon a mixture of an alkali or alkaline earth sulphate or sulphide, limestone, and a reducing agent, or calcium sulphide and a reducing agent, with or without a catalyst such as iron or an iron compound ,at 800-1,000° C. The reducing agent may be partially or wholly omitted when reducing gases are present with the nitrogen, and the nitrogen and other gases may he dry or contain steam. The calcium may be introduced as lime or slaked lime or organis calcium salts, and calcium sulphide may be formed in situ. The reaction mixture may be in the form of lumps, granules, or fine powder, and may be heated externally or internally, for instance in the latter case by contact with burning gas giving a reducing flame. Pressure other than normal may he employed. Examples describe the treatment of mixtures of potassium sul-

phate, coal, and lime or calcium sulphide, in nitrogen or producer-gas. Ammonia may be produced by blowing steam into the reaction chamber.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25 ,Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

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465,411.—Chemical substances prepared for use in medicine and pharmacy.—May & Baker, Ltd., Garden Wharf, Church Road ,Battersea, London, S.W.11. March 17th.

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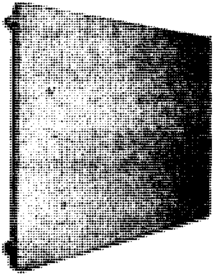

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Publisher's Announcements.

The following Books can be obtained from Rea and Inchbould, Merton House, Salisbury Square, London, E.C.4.

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THE CHEMICAL NEWS,

VOL. CXXXII. No. 3443.

MERTON HOUSE, SALISBURY SQUARE,
LONDON, E.C.4.

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LIPIN AND THE LIPIN THEORY.

By JOHN MISSENDEN, B.Sc.

So far as research has gone, it seems probable that the lipin to which the writer has referred to previously is, or at least has the nature of, a lipoclastic enzyme; and because of this, catalysts in chemical interchange (as in the case of its own hydrogenation) are entirely unnecessary. It has been found somewhat difficult to isolate a good specimen (although lipin is believed to exist in all animal tissue), but that contained in the liver will be found to answer to many of the reactions indicated by the manifestations of odour. It must be remembered, in considering whether a lipin reaction with an odiferous substance results in violent or mild chemical change, that what takes place in the beaker might not take place in the nasal passages. Nevertheless, the hypothesis that beaker and nasal membranes exhibit the same or nearly the same actional qualities is based upon such a wide and satisfactory series of tests that it may be taken for granted with safety.

Present knowledge of the constitution of nasal lipin is conflicting, and by no means complete. Nevertheless, it is generally agreed that it originates on the more exposed living cells—possibly as a by-product of their protoplasm—and that it has a definite function in regulating the "life-element" of those cells. Its influence seems to be twofold; to provide a protective surface for each cell, and to be sufficiently versatile in its properties as to provide each cell with a means of sensation.

Here the phenomena of smell is satisfactorily explained. Minute particles of a substance are taken into the nose and react with lipin. At once the molecular disturbances in the lipin are communicated to the living cell, and so smell is experienced.

So far, the question of the *intensity* of any odour has been carefully avoided, as this involves volatility and the laws of matter, which relate to it; a subject which bears more upon the mechanical side of odour, and which does not in any way influence *quality*.

MOLECULAR WEIGHT.

It is unsafe to discuss any relevant information apart from the reactions of lipin, as then some formidable difficulties will arise when it is discovered that an argument which might satisfy one group of substances will not satisfy another. At the same time, due importance must be given to conclusions drawn from constitutional formulæ.

This table by Durrans (*Perfumery Record*, May, 1919), throws some light upon the limits of the phenomena of odour.

In aliphatic saturated	Odour develops at	Reaches a maximum at	Is lost at
Alcohols	C_5	C_8	C_{14}
Aldehydes	C_1	C_{10}	C_{16}
Ketones	C_8	C_{11}	C_{16}
Acids	C_1	C_5	C_{14}
Esters	C_6	C_8	C_{17}

It appears that, wide in its application as this table is, there appears to be at least one exception to the generalisation it advances: *farnesol*, a sesquiterpene alcohol of group formula $(CH_3)_2C:CH.CH_2.CH_2.C(CH_3):CH.CH_2.CH_2.C(CH_3):CH.CH_2OH$. However, the table is a most handy guide for the field it covers.

The observations made by Durrans do not show any complete connection between molecular weight and odour, or between molecular potency, molecular distribution, and odour; but the table itself does demonstrate one very important rule; namely that, so far as the groups enumerated are concerned, molecular weight definitely controls limits at which odour is possible. It will be found more generally that the molecular weights of bodies capable of odour lie between 16 and 312, irrespective of whether they are organic or inorganic. But molecular weight has no apparent bearing upon quality of odour, as substances of almost the same molecular weight have widely different odours altogether, as in the case of geraniol and vanillin (152.178 and 152.104 respectively).

Molecular Force.

Here one is bound to accept the theory of Teudt (*Chem. Zent.*, 1919, 6. 138), coupled with the discussion of Durrans and Tschirch (*J. Chem. Soc.*, 1921, Abstracts I., p. 775). Durrans and Tschirch support the contention that odour is solely due to chemical reaction on the nasal membranes, and Teudt (whose work in this connection has been somewhat severely criticised by Heller (*Amer. Perfumer*, 1920, 365), states that odour springs from a condition of electrionic vibration. Collating the two arguments, it would certainly appear that odour is a condition of molecular force—a matter of valency and rate of chemical interchange. Thus the study of odour conditions lies in three separate directions, each of which is necessary to bring the subject within the range of accurate computation :

(1) The exact chemical constitution of the particular lipin associated with olfactory nerve-endings;
(2) The electronic forces which operate between lipin and all oriferous substances, and the rates at which they operate; and
(3) Matters which involve the phenomena of volatility.

It is the first two of these which form the basis of the Lipin Theory.

The writer would refer to his former paper in the *Chemical News*, 1923.

THE SCIENCE OF STEAM GENERATION.

Some Striking Tests at the Central Electric Supply Company, London.

By A Well-Known Engineer.

During the past few years steam generation, so far as large water tube boilers are concerned, has become an exact science, with continuous flue gas, as well as fuel, analysis, and complete pyrometric control in a manner hardly approached by any other furnace operation. The rapid progress made is well illustrated by the results of a series of remarkable 8-hour tests that have just recently been carried out at the Central Electric Supply Company's power station, St. John's Wood, London. These show an average of about 85% efficiency with mechanical stoking and coal of approximately 10,000 B.Th.U. per lb., all the more noteworthy when it is borne in mind "Murray-Usco" fin water-cooled tubes are not fitted, which would bring the results up to over 90%.

The plant under official test consisted of a "Babcock & Wilcox" water tube boiler, 200 lbs. pressure and 625° F. superheated steam temperature with a heating surface of 8,619 square feet and a superheater of 3,190 square feet, while the accessory equipment includes a "Green" economiser of 4,620 square feet and "Usco" air heater of 9,130 square feet, with 110 thin metal plates, electric welded in the outer casing to give 1 inch spaces, the normal evaporation of the plant as tested being 60,000 lbs. of water evaporated per hour.

The boiler is fired by three "Underfeed Class A" travelling grate forced draught stokers, installed by the Underfeed Stoker Co., Ltd., of London, giving a total of 308 square feet grate area, while the forced and induced fans are of the "Sirocco" type, by Messrs. Davidson & Co., Ltd., of Belfast. Finally, the coal used was Scotch Washed Peas, containing 15.85% moisture, with 10,379 B.Th.U. per lb., according to the lower or nett heating value, and Stanley slack, having 10.31% moisture and 10,000 B.Th.U., a low-grade quality.

The efficiency figures given in great detail are complicated as usual by considerations of nett and gross heating value of the fuel, but the average efficiency varied from 83.2% to 85.8% calculated on the gross or heating value of the coal without deducting the auxiliary power used. If the latter is taken into account as regards the power used for the fans and stoker, the actual nett efficiency is 82.4% to 85.1%, while if the lower or calculated so-called nett heating value is assumed the figures are 85.6% to 88.4% with the deduction of the auxiliary power, or 86.4% to 89.2% without. The amount of air used per lb. of fuel was 12.45 lbs., as compared with the theoretical figure of 8.50 lbs., an excellent performance, while the water evaporated per lb. of coal as fired was 7.94 lbs., corresponding to 9.83 lbs. from and at 212° F.

Some further detailed figures of the tests are that the CO_2 average 11.1 to 12.4%, while the temperature of the gases leaving the boiler varied from 525 to 540° F., and the feed-water economiser raised the temperature from 165-170° to 250-270° F. The average temperature of the air entering the air heater was 103-107° F., subsequently delivered to the stoker at 237-245° F., with an average velocity of about 535-629 feet

per minute and the flue gases leaving the economiser and entering the heater were 346-358° F., corresponding to only 255-262° F., on entering the chimney base after passing the heater, one of the main reasons, of course, for the high thermal efficiency. In general the tests are also a clear indication of the value of air heating, which is equally applicable to any type of boiler.

POTASH.

By George Rogers Mansfield and Leona Boardman.
(*U.S.A. Bureau of Mines.*)

The year 1924 was marked by continued low-price levels for foreign potash and was particularly noteworthy because of the signing in August of the Franco-German potash agreement, which virtually re-established the German-Alsatian potash monopoly. The American industry, however, not only held the place it had gained during the previous year, but made substantial gains. This was largely due to the work of the American Trona Corporation, which was the principal producer.

The number of plants reporting potash production in the United States was 11, one less than in 1922 and 1923.

Interest in the Texas potash field was sustained, as a larger number of wells in an increasing number of counties furnished data on potash resources. Among these wells was one in a salt dome in Matagorda County, which furnished the first real evidence of potash in connection with such a structural feature in the United States. An interesting find was also reported from Grand County, Utah, and an increasing interest developed in the brines of the Salduro Marsh, in north-western Utah.

A comparison of the figures for 1924 with those for 1918, when domestic production was at its height, shows that in 1918 the crude potash production was over four and one-half times as great as in 1924, whereas the available potash (K_2O) content of the material produced in that year was only about two and one-half times that for 1924.

In 1913, the last normal year before the war, the United States imported 270,720 short tons of K_2O. In 1924 the total imports were 200,365 tons, or 74 per cent. of that amount. This was 9,585 tons, or 4.6 per cent. less than the imports in 1923, but practically the same as the imports in 1922.

RECOMMENDED SPECIFICATION FOR QUICKLIME AND HYDRATED LIME FOR USE IN THE PURIFICATION OF WATER.

In the treatment of water for public supplies lime is used alone or with iron sulphate or aluminium sulphate to produce a precipitate which assists in the clarification of the water and in the removal of bacteria by filtration. Lime is used sometimes to partially soften the water. Lime and soda ash are used together for softening water. Quicklime is generally used in municipal plants and hydrated lime in smaller plants. For these purposes quicklime should contain at least 90 per cent. available lime and hydrated lime at least 90 per cent available calcium hydroxide.

Definition of Lime.

Quicklime is the product resulting from the calcination of limestone. It will slake when water is added to it, and this slaking is accompanied by an evolution of heat, and increase in volume, and the formation of calcium hydroxide. Hydrated lime is a dry powder which is made by treating quicklime with enough water to satisfy its chemical affinity.

Use of Lime in Water Purification.

In the treatment of water for public supplies lime is used alone or with iron sulphate or aluminium sulphate to produce a precipitate which assists in the clarification of the water and in the removal of bacteria by filtration. Lime is used sometimes to partially soften the water.

Lime and soda ash are used together for softening water. Quicklime is generally used in municipal purification plants and hydrated lime in smaller softening plants.

Quality.

The constituents other than calcium oxide ordinarily found in lime, and which include underburned and over burned lime, retard the slaking process. The presence of any inert material will thus introduce delays which reduce the efficiency of the equipment.

Packing.

Quicklime is shipped in bulk in carload lots or in wooden barrels or metal drums holding 180 pounds. Hydrated lime is shiped in paper bags holding 40 or 50 pounds net each.,

MARKING.

Each package, or each carload of bulk material, shall be legibly marked with the names of the consignor and the consignee, and with some means of identifying the particular contract on which the shipment is made. This information is in additon to that required by the Federal lime barrel law.

REQUIREMENTS.

Slaking.—When lumps of quicklime are immersed in water, they shall disintegrate readily into a suspension of finely divided material.

Composition.—The standard of composition for quicklime for use in water purification shall be a content of 90 per cent. available lime; for hydrated lime a content of 90 per cent. available calcium hydroxide.

Basis. — The percentages enumerated herein are based on the sample taken at point of shipment.

SAMPLING AND TESTING.

The purchaser will bear all expense of sampling and testing. When quicklime is shipped in bulk, the sample shall be so taken that it will represent an average of all parts of the shipment from top to bottom, and shall not contain a disproportionate share of the top and bottom layers, which are most subject to changes. The sample shall comprise at least 10 shovelsful taken from different parts of the shipment. The total sample taken shall weight at least 100 pounds, and shall be crushed to pass a 1-inch ring, mixed thoroughly, and "quartered" to provide a 15-sample for the laboratory.

When quicklime is shipped in barrels, at least 3 per cent. of the number of barrels shall be sampled. They shall be taken from various parts of the shipment, dumped, mixed, and sampled as in the above paragraph.

The sample of hydrated lime shall be a fair average of the shipment. Three per cent. of the packages shall be sampled. The sample sball be taken from the centre to surface of the package. The material so obtained shall be mixed thoroughly and "quartered" to provide a 2-pound sample for the laboratory.

When sampling quicklime or hydrated lime, it is essential that the operation be conducted as expiditiously as possible, in order to avoid undue exposure of the material to the air. The sample to be sent to the laboratory shall be placed immediately in an air-tight container, in which the unused portion shall be stored until the shipment has been finally accepted or rejected by the purchaser.

Details regarding the complete analysis of lime are given in other papers of this series and in Bulletin 700 of the United States Geological Survey.

(*a*) *Available Lime.*—Weigh 1.40 grams of quicklime or 1.85 grams of hydrated lime which has been carefully prepared and finely ground (passing a No. 100 sieve). Place in a 250 cubic-centimetre beaker, add 200 cubic centimetres of hot water, cover, heat carefully, and then boil for three minutes.

Cool, wash down, cover, add two drops of phenolphthalein, and titrate with half-normal hydrochloric acid, adding the acid as rapidly as possible dropwise, stirring vigorously to avoid local excess of acid. When white spots appear, retard the rate of addition of acid somewhat, but continue until the pink colour fades out throughout the solntion for a second or two. Note the reading and ignore the return of colour.

Repeat the procedure of paragraph 1 above, using (instead of the beaker) a one-half litre graduated flask carrying a one-hole stopper fitted with a short glass tube drawn out to a point, with the smaller end open and upward. Cool ,add dropwise 5 cubic centimetres less acid that before, stirring vigorously. Call the number of cubic centimetres used "A." Grind up any small lumps with a glass rod slightly flattened at one end, dilute to the mark with distilled water, stopper, mix thoroughly for four or five minutes, and let settle for half an hour.

Pipette a 200 cubic centimetre portion, add phenolphthalein and titrate slowly with half-normal hydrochloric acid until colourless on standing one minute. Call this additional number of cubic centimetres "B." The per cent. of available lime in quicklime or of available calcium hydroxide in hydrated lime is A + 2.5 B.

RE-TESTING.

Notice of the rejection of a shipment based on these specifications must be in the hands of the consignor within 10 days after the receipt of the shipment at the point of destination. If the consignor desires a re-test, he shall notify the consignee within five days of receipt of the notice of rejection. The original testing laboratory shall keep the sample sealed air-

tight from the time they have taken out enough material for the original test until the expiration of the 15 days noted. The original testing laboratory shall agree to transmit the sample to any other laboratory for a retest at the direction of both of the contracting parties. The re-test shall be at the expense of the consignor.

DEFLECTING A FLAME IN THE ELECTRIC FIELD.

Mr. Yuzaburo Shibata read a paper on the above subject before the Chemical Society of Japan on February 5, 1926.

He says that " it is well known that a flame deflects itself when it is brought into an electric field. This fact can be explained as the result of the migration of the oppositely charged ions of a flame in different directions in an electrie field. So we can catch differently charged particles in separate vessels and analyses them."

Having described the experiments, he publishes a table to shew that carbon dioxide is always in excess at the negative electrode than at the positive. The reason of this fact might be explained as follows. The molecules of a gas will split up into atoms or atomic groups in the intermediate stages of combustion, and some of the atoms or the atomic groups thus formed will be charged. It is probable that the carbon atom or the atomic groups CH, CH_2 CH_3 etc., have the positive charges, for the glowing carbon particles of a luminous flame in an electric field are strongly attracted to the negative electrode.

Flame Containing Sodium Chloride Vapour. In this case the sodium atom is supposed to be charged positively, and the chlorine atom negatively. This has been shown by the following experiment. When small silver plates are placed perpendicular to the electric field at a small distance from the flame at each side on the electrode, a purplish white deposit of silver chloride is seen on the surface of the silver plate on the side of the positive electrode, notwithstanding that the flame is deflected to the negative electrode as a whole.

Flame Containing Cupric Chloride. The flame has been obtained by blowing the ammoniacal solution of cupric chloride into the coal gas flame. In this case the copper atom is charged positively, and the chlorine atom negatively, which has been shown hy a similar experiment as above. Reddish deposit of copper was seen at the negative electrode, while whitish deposit of silver chloride at the positive electrode.

General Notes.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY.

Professor of Entomology Appointed.

The Governing Body of the Imperial College of Science and Technology South ensington, London, have appointed Mr. Frank Balfour-Browne to the Professorship of Entomology in the College, in succession to the late Professor H. Maxwell Lefroy. Professor Balfour-Browne, who was formerly Lecturer in Zoology (Entomology) in the University of Cambridge, has been Acting Professor of Entomology at the Imperial College during the present year.

THE OPTICAL CONVENTION.

Under the Presidency of the Astronomer Royal, Sir Frank Dyson, M.A., LL.D., D.Sc., F.R.S., the third Optical Convention will be held at the Imperial College of Science and Technology during the week commencing April 12.

Optical Conventions were held in 1905, under the Presidency of Sir Richard (then Dr.) Glazebrook, and in 1912, under that of Professor Silvanus P. Thompson.

Very notable advances have been made in Optics in Great Britain since 1912, as a result of which progress in every direction has probably been much more rapid than in any previous period in the history of British Optics.

The Convention has the support of the various Optical organisations, of representatives of Government Departments (including those from the three fighting services), of the Presidents of the Royal Society, the Royal Society of Medicine, and other learned Societies having an interest in Optics in its application to their own special subjects; and of many distinguished scientific men.

The activities of the Convention will include : —

A presidential address; meetings for the readings and discussion of papers on subjects of an optical character, including ophthalmology, astronomy, microscopy,

photography, kinematography, and optical instruments for warfare, navigation and aerial survey; lectures of a popular character, accompanied by demonstrations.

The Exhibition will be the most representative collection of British Optical Instruments ever shown, and will include research and experimental apparatus loaned by individuals, research laboratories and institutions; historical optical apparatus; and commercial exhibits. Among the commercial exhibits will be shown the latest productions of the British optical instrument industry.

Full particulars of the privileges and subscriptions of membership of the Convention may be obtained from the Secretary, Mr. Thomas Martin, The Optical Convention, 1, Lowther Gardens, Exhibition Road, S.W.7. A free ticket for a single admission to the Exhibition will be sent on application (with which a stamped addressed envelope should be enclosed.

ALBERTA (CANADA) OIL WELLS SHOW HIGH AVERAGE YIELD.

In comparison with the average production in other oil fields of the world, Alberta oil wells now producing show a high average. The Royalite well south of Calgary, in the Turner Valley field, is producing 400 barrels a day of almost pure naphtha, while wells in the Wainwright field east of Edmonton are producing from 80 to 100 barrels a day. This compares with an average of 6.59 barrels in 298,915 wells in the United States in 1924, with an average of 55.53 in California, of 20.9 in Texas, of 8.32 barrels in Oklahoma, of 20.63 in Montana Rocky Mountain area, of 41.84 in Wyoming.

BORON TRIFLUORIDE.

The freezing point curve of the system boron trifluoride-hydrogen sulphide has been investigated, and has been found to contain two eutectics, a maximum corresponding to $BF_3.H_2S$, with freezing point - 137°, and a transition point of a compound $BF_3.7H_2S$ at - 99°.

Judging from the flatness of the curve at the maximum, the compound $BF_3.H_2S$ is considerably dissociated, so that there should be little difficulty separating H_2S as an impurity from BF_3 by fractional distillation.—F. O. Gerald and Harold Simmons Booth (*Journal of the Franklyn Institute*).

NITRO-COTTON.

The following substances have no visible effect upon nitro-cotton, although it is certain that they all combine with it to various extents; water, benzene, toluene chloroform, ether, petrol, tolyl carbonate, dibenzyl ether.—J. W. McBain, C. E. Harvey, L. E. Smith (*Journal of the Franklyn Institute*).

SAGUENAY (CANADA) ZINC SMELTER.

The Saguenay River district is to witness the creation of a new industry in the near future, according to despatches reaching the city of Quebec. An Americau syndicate, with headquarters in New York, is understood to have in consideration the construction of a zinc smelter in the Saguenay district ,choosing this site because of the fact that there is plenty of electric power available, as well as a deep water port that is open for the greater part of the year. The company expects to produce about 100,000 tons yearly, and 50,000 horse-power will be needed to operate the plant.

UTILISATION OF DEVELOPED WATER POWER IN CANADA.

A study of the uses to which the water power installation of Canada is put emphasises the growing importance of central electric stations. The 4,290,428 h.p. at present installed throughout the Dominion is apportioned to the following uses:—3,466,422 h.p., or 80.8% of the total, in central electric stations for general distrimution for domestic, municipal ,and commercial lighting and power purposes; 481,971 h.p., or 11.2% installed in 116 pulp and paper mills (in addition pulp and paper mills purchase about 275,000 h.p. from central electric stations, making a total of nearly 757,000 h.p. used in the manufacture of pulp and paper); 342,035 h.p., or 8.9%, installed in industries other than central electric stations and pulp and paper mills.

The total installation for the Dominion averages 465 h.p., per 1,000 of population, a figure which places Canada among the leading countries of the world in *per capita* utilisation of water power.

There are at the present time 297 hydro-electric stations with a total installation of 3,466,422 h.p., 209 of which, with an installation of 4513 turbines giving a combined capacity of 2,230,848 h.p., being

owned by commercial organisations and 88 stations with 213 turbines aggregating 1,235,574 h.p. being publicly owned.

Individual turbines vary in size from the 10 h.p. turbine used for hamlet lighting, to the 55,000 h.p. units of the great Chippawa-Queenston station, while contracts for units of 80,000 h.p. for installation in the Saguenay river plant of the Aluminium Corporation of Canada have recently been let.

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL SOCIETY.

Papers read at the meeting held on February 4, 1926.

Stereoisomeric Diaryl-β-γ-Diamino-N-Butanes. By G. T. Morgan, F.R.S., W. J. Hickinbottom, and T. V. Barker.

The secondary diamines of the general type Ar.NH.CH(CH_3).CH(CH_3).NH.Ar contain two asymmetric carbon atoms, either mirror images of each other or absolutely identical. Like tartaric acids, these bases should exist in an internally compensated *meso*-form, as well as an externally compensated mixture, potentially resolvable into optically active modifications. Moreover, the compensated mixture may belong to one of three categories :—

(1) true racemoid inseparable by purely physical agencies; (2) conglomerate of *d*- and *l*-crystals, mechanically separable in various ways; or (3) pseudoracemoid or special kind of mixed crystal, containing *d*- and *l*-components in variable proportions.

The most fully investigated series of compounds are those containing the *p*-tolyl residue,

$$CH_3.C_6H_4.NH.CH(CH_3).\dot{C}H(CH_3).NH.C_6H_4.CH_3,$$

and the study of these bases affords a highly satisfactory confirmation of the requirements of stereochemical theory; inasmuch as a *meso*-isomeride has been isolated in every case examined. These diamines and their *cyclo*methylene- and piperazino-derivatives also furnish an interesting suite of externally compensated mixtures, including at least one example of each of three possible categories.

dl-Di-*p*-tolyl-*β*-*γ*-diamino-*n*-butane is shown to exist as a conglomerate of *d*- and *l*-forms, and optically active antipodes are separated by a new method without reference to hemihedral structure of crystals.

Antimonial Analogues of the Cacodyl Series. By G. T. Morgan, F.R.S., and G. R. Davies.

Methyl arsenicals were first discovered by Louis Claude Cadet de Gassicourt in 1760 (Paris, Acad., Sci. Mém. Div. Sav., t. 3, p. 623). His fuming liquid was shown to consist of dimethylarsine oxide and tetramethyldiarsine by the researches of Bunsen, Dumas, Cahours and Riche, and by the theoretical deductions of Berzelius and Frankland.

Similar experiments on organic compounds of antimony led to the preparation of tertiary stibine and other derivatives by Löwig and Schwizer and by Landolt, but the antimonial analogues of the cacodyl series have so far eluded isolation.

We have now investigated the thermal decomposition of trimethylstibine dihalides, the following reaction having been generalised when X is chlorine, bromine or iodine :

$$(CH_3)_3SbX_2 = (CH_3)_2SbX + CH_3X$$

This process has afforded the means of proceeding from the tertiary to the secondary series or organic antimonials.

Dimethylstibine Cyanide, and Analogue of Cacodyl Cyanide. By G. T. Morgan, F.R.S., and V. E. Yarsley.

When anhydrous reagents are used, cyanogen bromide combines readily with trimethylstibine dissolved in light petroleum to form *tribethylstibine cyanobromide*, a white crystalline compound which is readily hydrolysed by moisture, giving the corresponding *trimethylstibine hydroxybromide.*

Apart from the ease with which it is hydrolysed, the cyano-bromide is relatively stable, and it is only decomposed *in vacuo* at high temperatures, when *dimethylstibine cyanide* is obtained as a colourless crystalline compound, m.p. 113—114°. This cyanide, the analogue of Bunsen's cacodyl, fumes on exposure to air, with the formation of white infusible *trimethylstibine oxycyanide.*

With moist silver oxide trimethylstibine hydroxybromide yields *trimethylstibine dihydroxide*, a stable compound which with phosphorus pentachloride and hydrochloric acid yields respectively *trimethylstibine dichloride* and *trimethylstibine hydroxychloride.*

INSTITUTE OF METALS.

The following papers were read at the Annual General Meeting of the Institute of Metals, held in London on Wednesday, March 10, 1926 :—

The Interpretation of the Macrostructure of Cast Metals. By R. GENDERS, M.B.E., M.Met., F.I.C.

The interpretation of the structure of cast metals and alloys has depended mainly on empirical observation. While in the case of steel the macrostructural characteristics of a casting give definite information regarding casting conditions, the same indications cannot be appled directly to cast specimens of non-ferrous alloys, particularly to those consisting largely of coper, which solidify rapidly. The work described has the aim of establishing grounds upon which a more general interpretation of the macrostructure of metals, and consequent knowledge of the mechanism of the solidification of a casting, can be based. In copper alloys of high thermal conductivity, solidification occurs concurrently with pouring and the flow of metal within the mould becomes of primary importance in governing the mode of crystallisation. Experimental slab ingots 12 × 6 × 1 inch were made of two alloys of similar physical characteristics, but of different colour, melted in separate crucibles. By the use of a specially designed pouring-trough the metal passed into the mould in an nnbroken stream, while the alloy comprising the stream could be changed at any pre-arranged stage by varying the amounts of metal in the two crucibles. The disposition of the colour zones distinguishable on sections from the ingots indicated that the process of formation of the ingot from the stream was one of continuous displacement of metal in the path of the stream to the faces of the mould. Several sets of casting condition, covering most of those used industrially, were included in the experimental work. The conclusions drawn concerning the mechanism of the formation of a casting, permit of the interpretation of many peculiar features observed in the structures of ingots of copper alloys.

The affect on macrostructure of the temperature range over which the alloy solidifies is considered, and the theory accounting for the formation of equi-axed crystals by concentration variations in the region of the liquid-solid interface is developed and applied to a number of practical cases. In all metals having no freezing range, cast by ordinary methods, a completely columnar macrostructure is formed unless special precautions (which can be prescribed) are taken to avoid it.

The method for determining the mode of formation of the casting by the use of two alloys is applicable industrially in connection with the design of moulds and casting methods.

The Hardness of Cold-Rolled Copper. By SAMUEL L. HOYT, E.M., Ph.D., AND T. R. SCHERMERHORN.

Hardness tests of two series of cold-rolled copper bars are reported in detail, one which had received a 2 per cent. and one a 10 per cent. reduction in thickness per pass. These confirm the old or "conventional" form of relationship between the degree of working and the bardness. In neither case did the authors find either the anomaly noted by Alkins (the "Alkins effect") or the reversal noted by Rawdon and Mutchler. However, they do believe that they have observed a well-pronounced Alkins effect on another series with heavier reductions not recorded here. The deviations from a smooth curve which may be seen on the hardness curves may be accounted for as due to unavoidable experimental errors. The draft per pass had only a subordinate effect on the hardness, but, in the two cases reported in detail, the 10 per cent. reduction have a greater increase in hardness than did the 2 per cent. reduction per pass.

The hardness over the cross section was found to be uniforn for reductions above 20 per cent. At the start, with small reductions, the authors found the top surface to be harder than the side of the test-bar. This difference disappeared at about 10 to 20 per cent. reduction.

Researches on the Nature, Properties and Conditions of Formation of Intermetallic Compounds with Special Reference to Certain Compounds of Tin. Parts I-IV. By W. HUME-ROTHERY, M.A.

PART I.—The theoretical proof of the Phase Rule is discussed. The Phase Rule really involves volume concentrations, but is commonly used for weight composition equilibrium diagrams. This is generally justifiable, but whenever volnme changes occur unaccompanied by weight changes, the Phase Rule in its usual sense will not

apply to the weight composition diagram. The proof of the Phase Rule also involves assumptions regarding the nature of the equilibrium between phases, which are not justified in the case of a solid crystalline compound of the components. When such a compound is formed, the variability of the system is greater than the Phase Rule indicates.

PART II.—In contrast to other compounds, intermetallic compounds conduct electricity. They are formed in such a way that some only of the available electrons are bound into stable groupings, others being more loosely held. This conception accounts completely for their irregular valency relations. A true binary intermetallic compound will very rarely give rise to the substitutional type of solid solution, but the interstitial type is possible although it will usually be limited in extent.

PART III.—A true compound is not present in the β solid solutions of copper, silver, and gold alloys, but these phases approximate to the compositions Cu_5Sn, Cu_3 (or Ag_3), Al, and Cu (or Ag, or Au) Zn. In all of these there is a ratio of 3 valency electrons to 2 atoms, and the phases are regarded as space lattices of electrons and atoms with a fundamental ratio of 3 : 2, but with no compound molecule in the liquid state. This conception accounts for the electrical properties of these compounds, and agrees with Lindemann's theory of the metallic state. The position of electrons in metallic crystals is discussed.

PART IV.—The freezing point diagram of the system calcium-tin is determined. Three compounds are formed, *viz.*, $CaSn_3$ (max. of f.pt. curve at 627° C; do = 6.01); CaSn (break in liquidus curve at 987° C.; do = 4.17); and Ca_2Sn (max. on liquidus at 1122° C.; do = 3.47). No solid solutions are present. The properties of the compounds are examined, and it is shown that a natural crystal face is oxidised more slowly than a ground or polished section.

PART V.—A freezing point diagram of the system magnesium-tin is determined. A very slight range of liquid immiscibility probably exists at the tin end of the diagram. The single compound is Mg_4Sn_2 and not Mg_2Sn. It melts at 778° C., and is blue black with octahedral cleavage.

The compound Na_2Sn is also blue black with octahedral cleavage. It undergoes a remarkable reaction with water, the compound being completely decomposed, but retaining its original form, the whole mass being honeycombed with minute cracks parallel to the octahedral cleavages of the original crystal.

The Brittle Ranges of Bronze. By W. L. KENT, B.Sc., Member.

The brittle ranges of cast and annealed bronzes containing up to 25 per cent. of tin were investigated, using the Izod impact test in the manner employed by Bunting (Bunting, *J. Inst. Metals*, 1924, XXXI., 47; *ibid.*, 1925, XXXIII., 97), and the results correlated with the known facts concerning the workability of the alloys.

It was shown that alloys in the α range were brittle at high temperatures, whilst those containing the $\alpha + \delta$ eutectoid, which are hard and brittle at ordinary temperatures, become softer and tougher above 520° C., due to the formation of β which takes place at that temperature. The maximum toughness occurred in the neighbourhood of 600° C.—an observation which is in agreement with the results of different tests performed by other workers. The effect of annealing was to bring the alloys nearer to equilibrium so that the extent of the brittle range at ordinary temperatures was diminished.

The Influence of Gases at High Temperatures. Part I. By A. GLYNNE LOBLEY, M.Sc., Member, AND DOUGLAS JEPSON, M.Sc., Member.

The paper describes briefly a special type of electric resistance furnace, in which the resistor is a plain carbon tube mounted vertically in water-cooled electrodes. The furnace can be evacuated, or filled with any desired gas, and an arrangement is provided by which a crucible containing the metal under treatment can be lowered from the reating zone into a water-cooled compartment, thus giving a very rapid and reproducible rate of cooling.

Electrolytic copper was heated in atmospheres of nitrogen, hydrogen, and carbon monoxide respectively, to various temperatures between its melting point, 1084° C., and its boiling point, 2310° C., being kept at the given temperature for a period of 30 minutes. The metal was then cooled rapidly in the manner stated, and examined for blowhole volume, hardness, and macrostructure.

It was shown that nitrogen and carbon monoxide are not absorbed by molten

copper up to temperatures of 1900° C., and 1700° C., respectively, in excess of that soluble in the solid metal. Hydrogen, on the other hand, is absorbed to a varying degree at all temperatures up to approximately 2200° C., and the excess over that soluble in solid copper is ejected on solidification forming blowholes. The amount of gas thus held appears to bear a definite relation to the solubility of the gas at the temperature under consideration. The blowhole volume/temperature curve falls from the melting point to a minimum at approximately 1350° C., rising to a maximum at 1750° C., then falling as the temperature rises to approximately 2200° C.

The macrostructure showed certain changes in the grain size regarding which further investigation is required. The Brinnell numbers were found not to vary beyond the limits of experimental error from an average value of 5 with either temperature or the nature of the gas to which the metal was subjected.

Die-Casting of Aluminium Alloys, By GEORGE MORTIMER, Member.

From the utility standpoint one of the interesting attributes of the metal aluminium is the ease with which its alloys may be "die-cast." The economic value of die-casting in general is now widely admitted and need not be unduly stressed here. It is so generally recognised that the die-casting of brass and the bronzes have received close and costly attention of late, whilst in America at least one firm is successfully producing iron castings from permanent moulds.

Neither in brass nor in iron, however, is the operation carried out with any of the specifications for aluminium casting alloys, nor do the moulds cost so little or last so long. This fact, coupled with the designers' long experience of these alloys under all sorts of service conditions, has been one of the more active influences in the very striking developments which have taken place in the past decade, in the application of die-castings to engineering and industrial uses.

The development in the use of die-castings in Europe and America has not only been remarkably rapid, but has also inevitably proceeded on lines most suited to the conditions obtaining in different countries. Inevitably, also, a certain confusion arises in regard to the possibilities, technical and economical, of the different systems employed. The present paper is intended simply to crystallise the ideas of those who are interested in die-castings, yet who are kept too fully occupied in their own legitimate sphere to keep in touch with developments in specialised branches of engineering.

The Constitution of the Alloys of Silver and Tin. By A. J. MURPHY, M.Sc., Member.

In connection with an investigation of dental amalgams the constitution of the alloys of silver and tin has been determined from the freezing point down to ordinary temperatures. Based mainly on the results of heating and cooling curves and microscopic examination of heat-treated specimens, an equilibrium diagram has been constructed. The compound Ag_3Sn, which is the fundamental constituent in the filings used for amalgamation in dental fillings, has been examined in further detail by means of determinations of electrical resistance at different temperatures, thermal expansion and X-ray examination.

The diagram now presented differs from that hitherto accepted in showing a new phase β in a range of alloys formerly believed to consist entirely of an α solid solution, and also in excluding a polymorphic transformation at 232° C., which was said to occur in the compound Ag_3Sn. Evidence has been obtained for a transformation at 60° C., in this compound, but the nature of the change is not clear. The lines of the X-ray spectrogram obtained from filings, both aged and unaged, from an annealed ingot corresponding in composition to the compound Ag_3Sn, are accounted for by a close-packed hexagonal structure of side 2.98×10^{-8} cm. and axial ratio 1.61.

Experiments with pure tin and alloys of tin containing silver have shown that the presence of 0.2 per cent. of silver prevents the transformation from white to grey tin, even when in contact with the grey tin.

Striation due to Working or to Corrosion in Microscopical Metallography. A Contribution to the Study of the Mode of Action of Etching Reagents. By A. M. PORTEVIN.

There is no phenomenon, however minute or secondary it may appear, which cannot furnish material for interesting study if trouble is taken to examine carefully its mode of occurrence and its appearance. There is, for example, in microscopical metallography the appearance after etching

of certain striations produced by the polishing of metals and alloys. This is a well-known fact, and a source of great annoyance to all who seek to obtain perfect pictures of the structure free from these scratches; from this point of view they are but nuisances which are, if possible, avoided by suitable methods.

But this annoyance may incidentally become the starting-point for suggestive observations if a closer study is made, particularly in the case of metals and alloys having a crystallisation coarse enough to permit a close survey of the phenomenon on individual grains; for this purpose samples are used which have been very slowly cooled from the liquid, so as to have very well-developed crystal grains; this is what has been done in the case of examples given in this paper. In addition to this it is advisable to work on metals and alloys having a low elastic limit, such as copper and solid solutions of brass or aluminium-bronzes which are very rich in copper, in which cases the effects of work due to the polishing scratches are more intense and noticeable to a greater depth. In a previous paper on etching figures, the author has shown that these constitute one of the decisive characteristics for determining the crystalline state of the grains, and are a definite means for showing the differences of crystalline orientation in these elements of the structure. All disturbances of the crystalline structure, and particularly any deformation of the lattice, must therefore affect the etching figures, which can be developed by suitably etching the surface.

The Copper-Rich Aluminium-Copper-Tin Alloys. By D. STOCKDALE, M.A., Ph.D., A.I.C., Member.

In this paper the effect of tin up to 9 per cent. by weight on the structure of the yellow aluminium-copper alloys is discussed. A remarkable feature of these ternary alloys is the manner in which the two binary systems merge into each other; there is no abrupt change in a series of solid solutions and the difference between the structure of aβ-bronze and a β-aluminium-copper solid solution, for example, is small.

The line on the ternary diagram marking the limit of the α-solid solution is nearly straight at high temperatures. At ordinary temperatures, however, is is slightly curved, because when the two added elements are present in about equal proportions, the temperature of the eutectoid transformation is raised about 100° C.

In a certain small number of these alloys the eutectoid transformation does not take place, but near 600° C. the ordinary β-solid solution changes over to a second colid solution indistinguishable microscopically from the first. A proportion of the solid solution poor in copper may dissolve in this new constituent, and ,on further cooling, the copper-rich α-phase separates out, but the mother constituent persists down to the ordinary temperature. It is for this reason and also because tin has a retarding influence on the ordinary eutectoid transformation in the aluminium-copper alloys that there are grounds for hoping that a ternary alloy for practical use may be found which will possess the advantages, with none of the disadvantages, of "aluminium-bronze."

The Mechanical Properties of an Alloy of Nickel and Copper, with Special Reference to "Creep." By H. J. TAPSELL, A.C.G.I., AND J. BRADLEY, B.A., B.A.I.

The paper deals with the results of some mechanical tests carried out on a synthetic alloy of nickel and copper (approximately 70 : 30), containing 2.35 per cent of manganese, at a range of temperatures between air temperature and 700° C., to 800° C. The methods of test and the apparatus used are identical with those described in a paper by the authors, published in *Engineering* (*Engineering*, CXX., 614, 648, 746), on the mechanical properties of a nickel-chromium alloy.

The tests herein described consist of the following :— Ordinary tensile, torsion, impact, impact hardness, fatigue under reversed stresses, and "creep."

Special attention is given to the study of the "creep" of the nickel-coper alloy, and determinations of the limiting creep stresses have been made between the temperatures 400° C., and 700° C. The paper indicates the large difference existing between the apparent ultimate strength, as determined by tests made at the ordinary rate of loading, and the safe strength, or limiting creep stress, obtained from tests made under constant loading conditions over long periods.

Some comparisons of the results obtained in the ordinary tensile tests and the creep tests on the nickel-copper alloy, and the results of other experiments on Monel metal and other alloys, are given at the conclusion of the paper.

The tests described form part of an investigation of the mechanical properties at high temperatures of several ferrous and non-ferrous materials, and the results of the tests on the nickel-copper alloy have been given in this paper mainly for the purpose of showing that such a synthetic alloy of nickel and copper can be made, which will give a satisfactory performance at high temperatures.

INSTITUTION OF FUEL TECHNOLOGY.

Following upon the largely attended inaugural meeting held on the 5 March last at the Institution of Civil Engineers, London, the Organising Committee appointed thereat held their first meeting on Tuesday, 23rd March.

In the first place it was definitely decided to adopt the name "Institution of Fuel Technology," which covers the wide field of activities the new Institution will represent. Within the limits of their powers of co-option of additional members the Organising Committee are extending invitations to other organisations to be represented, patriculars of which will be announced in due course. Lord Montagu of Beaulieu has already intimated his iutention to join the Committee.

A Sub-Committee was appointed to draft with all speed, a constitution and bye-laws, and held its first session on the 26th March. It will meet at least once a week until the work is completed. This draft constitution will then be considered in detail by the Organising Committee and eventually a copy will be sent in advance to everyone interested, for consideration, prior to a second public meeting which will be called to adopt or amend as the potential members may think fit.

All communications should be addressed to the Hon. Secretary (pro. tem.), Mr. Edgar C. Evans, Caxton House (East) T[illegible]ill Street, Westminster, S.W.1.

GRAPHITE.

By Jefferson Middleton.

(U.S.A. Bureau of Mines.)

The graphite industry in the United States suffered a considerable setback in 1924, when the number of active operators, the output, and the value all decreased. In Alabama, which showed the greatest development in response to the war demand and was for many years the leading producer, the industry has almost ceased to exist. Many, if not most of the plants that were established there have been abandoned or dismantled on account of their inability to produce graphite in competition with the cheap foreign supply, in spite of the tariff of 1½ cents a pound on imported crystalline *flake graphite.* In Texas, the only other State producing crystalline graphite, production was also curtailed by enforced idleness for the greater part of the year. The increased price of graphite in 1924—the most interesting feature of the year in the industry—may stimulate domestic production, but it is doubtful whether the industry will be permanently resuscitated. Imports also decreased, as did the production of artificial graphite.

Uses.

Natural graphite is used chiefly in the manufacture of crucibles, lubricants, pencils, foundry facing, paints, stove polish, and dry batteries. Small quantities are also used in electrotyping and as a preventive of boiler scale. The large consumption of graphite for the manufacture of crucibles seems to be threatened by the decreasing demand for crucibles through the increasing use of electric furnaces. The percentages of consumption in the various industries in recent years have been estimated as follows: Crucibles, 45 per cent; lubricants, 10 per cent.; pencils and paints, 5 per cent.; foundry facing and stove polish, 30 per cent.; other uses, 10 per cent.

Production.

The sales of domestic graphite in the United States fell from 6,038 short tons in 1923 to 4,971 tons in 1924, a decrease of 18 per cent. This decrease was entirely in the crystalline variety, which declined 2,164,575 pounds, or 55 per cent. The amorphous variety increased slightly in output—15 tons—compared with 1923. Crystalline graphite was produced in only two States in 1924, Alabama and Texas.

FORGOTTEN CHEMISTS.

Professor Edgar F. Smith, University of Pennsylvania, delivered an interesting lecture on this subject at Los Angeles, and same is reprinted in the Journal of *Chemical Education.* There are published also a number of photos of the neglected brethren. Among the names allowed to drift into

oblivion are Stephen Franz Geoffrey, Wilhelm Franz Ronelle, Andreas Sigismund, Marggraf, Robert Kerwan, Johann Gotschalk, Wallerium, Jean a de Luc, Johann Iugenhouz, John Christian Wiegleb, Thorburn Bergmann, Von Diemann, Johann Friedrich Gonelin, Franz Carl Achard, Joseph Von Jacquin, Sigismund F. Hermbstadt, Ambrose Godfrey, and Dr. J. B. Trommsdorff.

RECENTLY-RECEIVED PUBLICATIONS.

Service and Regulatory Announcements. (United States Department of Agriculture.)

Index to the U.S.A. Bureau of Mines Publications.

Coke Oven Accidents in the U.S.A. during 1924.

Plastic Magnesia (U.S.A. Department of Commerce).

The Measurement of Humidity in Closed Spaces. Department of Scientific and Industrial Research, H.M. Stationery Office. 2s. net.)

Relative Merits of Cotton and Jute Cement Sacks. (Department of Commerce, U.S.A.)

Water Power and Flood Control of Colorado River Below Green River, Utah. (B. E. C. la Rue, Washington Government Printing Office.)

Surface Water Supply in the U.S.A. in 1921. Part XII. (Washington Government Printing Office.)

The Papago Country, Arizona. With numerous maps. By Kirk Bryan (Washington Government Printing Office).

U.S.A. Government Master Specification for Builders' Hardware. (U.S.A. Bureau of Standards, Washington, D.C.)

Flow in Low Carbon Steel at Various Temperatures. By H. J. French and W. A. Tucker (U.S.A. Bureau of Standards).

Spark Photography and its Application to some Proplems in Ballistics. (Bureau of Standards, U.S.A.)

Motor Vehicle Head Lighting. (U.S.A. Department of Commerce.)

The Technology Papers of the Tohoka Imperial University, Sendai, Japan.

Transactions of the Royal Canadian Institute. (University of Toronto Press. December, 1925.)

Buletinul Societatei de Chimie de Romania. (Splaiul G.-Ral Magheru, 2, Bucuresti.)

Journal of Physical Chemistry. (Ithaca New York.)

A Comparative Study of Paper Fillers. (U.S.A. Bureau of Standards.)

Condensation of Water from Engine Exhaust for Airship Ballasting. (U.S.A. Department of Commerce.)

The Flora of the Ripley Formation. (U.S.A. Geological Survey, Washington.)

National Bureau of Standards (U.S.A.) and its Functions.

Silver, Copper, Lead and Zinc in Central United Stated in 1924.—Asphalt and Related Bitumens in 1924.—Investigation of Synthetic Tanning Materials.—Metallurgical Etching Reagents. (U.S.A. Bureau of Standards.)

Standards Time Throughout the World. U.S.A. Bureau of Standards, Circular 280.

This paper gives a brief historical sketch of the development of the standard time system, a map shewing the true zone boundaries in the United States, and a list of the official stations sending out radio time signals. Time in nearly every foreign country is given, compared with both Greenwich mean time, and with noon eastern standard time.

FORTHCOMING EVENTS.

ROYAL INSTITUTION.

The After-Easter Lectures at the Royal Institution will begin on Tuesday, April 13, at 5.15 p.m., when Professor Barcroft will deliver the first of four lectures on "Organs of Multiple Function. (I) The Salivary Glands." These will be followed by three lectures by Dr. G. W. C. Kaye on the "Accoustics of Public Buildings" (The Tyndall Lectures); and two by Sir Percy Sykes on (I) "Shah Abbas of Persia, the Contemporary of Queen Elizabeth" (II) "Chinese Turkestan and the Pamirs." On Thursdays, beginning on April 15, there will be two lectures by Prof. O. H. P. Prior on (I) "French Rythm and English Poets in Norman and Modern Times" (II) "Anglo-Norman Literature."

ROYAL SOCIETY OF ARTS.

Wednesday, April 14, at 8 p.m. (Ordinary Meeting.) R. A. Dawson, A.R.C.A. (London), Principal, Municipal School of Art, Manchester, "Art Training

for Industry, and the Society's Competitions." Sir Frank Warner, K.B.E., will preside.

Friday, April 16, at 4.30 p.m. (Joint Meeting, Indian and Dominions and Colonies Sections). Lt.-Gen. Sir W. T. Furse, K.C.B., D.S.O., Director, Imperial Institute, "The Work of the Imperial Institute."

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

7,668.—Appel, R.—Electrolytic separation of metallic chromium. March 19.

7,151.—*British Dyestuffs Corporation*, Ltd.—Manufacture of acylhalides. March 15.

7,197.—Du Pont de Nemours & Co., E. I. —Recovery of antimony in manufacture of flavanthrone. March 15.

7 709.—Meyerhofer, A. F.—Production of complex hydrofluoric acids. March 19.

7,298.—Etablissements Poulenc Freres. —Manufacture of salts of alkaloids. March 16.

Specifications Published.

248,424.—Kalle & Co. Akt Ges.—Process for producing sulphur dyestuffs fast to chlorine.

248,453.—Ikeda, Dr. K.—Manufacture of glutamic acid and salts thereof.

248,523.—Newbery, G., & May & Baker, Ltd.—Process for the manufacture of monacyl derivatives of amino-arylarseno compounds.

248,593.—Tyryer, D. — Manufacture of barium nitrate.

248,683.—I. G. Farbenindustrie Akt. Ges. —Manufacture and production of iron carbonyl.

Abstract Published.

246,512.—Aluminium salts.—Lederer, O., and Stanczak, W., 5, Palacky St., Karlin, Prague. Jan. 23, 1926. No. 2058. Convention date Jan. 24, 1925. Not yet accepted. Abridged as open to inspection under Sect. 91 of the Act (Classes 1 (ii) and 1 (iii).)

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The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by *permission of the Controller of His* Majesty's Stationery Office.

PLASMOCHIN.

466,698.—Chemical substances prepared for use in medicine and pharmacy.— Bayer Products, Ltd., 31 to 34, Basinghall Stree, London, E.C.2.

NEO-CULTOL.

466,931.—Chemical substances prepared for use in medicine and pharmacy.—The Arlington Chemical Co., South Broadway, Corner of Vark Street, Yonkers, Westchester, New York, U.S.A. March 17th.

P-SIT.

466,652.—Glues.—R. Parkinson & Sons., Curzon Street, Drug Mill, Curzon Street, Burnley. March 24.

COLISTOL.

466,960.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—The Crown Chemical Co., Ltd., 52, Crutched Friars, London, E.C.3. March 24.

PARTAGON.

457,681.—Chemical substances prepared for use in medicine and pharmacy.—Chemical Works, Formerly Sandoz, 60, Fabrikstrasse, Basle, Switzerland. March 24.

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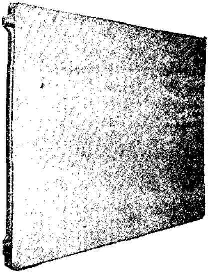

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Publisher's Announcements.

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THE CHEMICAL NEWS,

VOL. CXXXII. No. 3444.

MERTON HOUSE, SALISBURY SQUARE,
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Administrative : Central 6521.
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SOME RECENT ADVANCES IN CHEMISTRY.

The first quarter of the twentieth century has seen a remarkable advance in every branch of chemical science. Not only has increased knowledge been acquired by research along familiar lines, but new fields have been opened up by the aid of fresh implements with the result that many new fundamental conceptions have arisen and some old ideas have been discarded.

Most of these greater discoveries have occurred on the borderland of physics and chemistry, and are concerned with X-ray spectra, atomic numbers, isotopes, electrons, atomic structure and radioactivity.

All these and many other subjects are discussed in the new edition of Prof. A. W. Stewart's "Recent Advances in Physical and Inorganic Chemistry."*

The rapidity with which discoveries are being made may be inferred from the alterations made in this book compared with the fourth edition, which appeared as late as 1922. The author has written a dozen new chapters, and only three of those of the last edition remain intact.

As might be expected, much space has been devoted to researches which have increased our knowledge of the atom. The old notion that the atom was the unit engaged in chemical change has been disproved and the complex structure of the atoms of even the lighter elements has been established.

By studying the passage of an electric current through evacuated tubes, Crookes paved the way for the discovery of cathode rays, positive rays, and X-rays, all of which possess important characteristics that have been turned to good account in scientific work. When cathode rays impinge upon a metal surface, this emits characteristic X-rays of definite wavelengths, which can be photographed and measured. In this way Moseley discovered that the X-ray spectra of all the elements showed a definite regularity, enabling elements to be identified with certainty. By assigning (from calculations) each element an atomic number, in ascending order, according to the wave-lengths of the K lines, it has been possible to correct the old anomalies of the periodic Classification. Thus argon and potassium, and iodine and tellurinm fall into their proper groups, having the atomic numbers Ar, 18; K, 19; I, 53; and Te, 52.

The atomic number of uranium has been found to be 92. Assuming this to be the element of highest atomic number, there still remain a few elements to be discovered.

Until 1923 these included the element of atomic number 72 but in that year Coster and Hevesy announced its discovery by means of X-ray analysis in zircon minerals. Since Prof. Stewart's book appeared, the number of missing elements has been further reduced. In the last few weeks it has been announced that Prof. B. Smith Hopkins has discovered the missing rare-earth metal of atomic number 61, and during last year dvi-manganese of atomic number 75 was isolated in an impure state from manganese preparations. Eka-manganese has also been announced and the discovery of the rest has been foreshadowed in the *Chemical News*.

The importance of X-ray spectra in this field can hardly be over-estimated. The rare earth group of elements has long been one of the difficulties of chemical science and the definite proof of the exact number of these metals has eliminated the possibility of much valuable time and energy being lost in a futile search for others.

In the Periodic Classification, following barium, are the so-called rare earths (except scandium and yttrium). They were originally found in Scandinavia, but deposits have since been exploited in other parts of the world, especially America. Their separation and the elucidation of their chemistry has proved tedious, but is now fairly well known. Prof. Stewart's account

* *Recent Advances in Physical and Inorganic Chemistry.* By A. W. STEWART, D.Sc. 5th Edition. Pp. XII. + 312. London : Longmans, Green & Co., 39, Paternoster Row, E.C.4. 1926. Price 18s.

of these metals constitutes a valuable section of his book and his method of placing them in the Periodic System has much to commend it.

Urbain's work on the rare earths led to the view that element of atomic number 72 would belong to that group. The substance isolated by Coster and Hevesy, however, shows close similarity in properties with zirconium, with which it is associated in zircons and it undoubtedly belongs to the fourth group. Hafnium can be separated from zirconium either by taking advantage of the difference in basicity between the oxides or by utilising the different solubilities of the double potassium fluorides. Other hafnium compounds very closely resemble those of zirconium in properties. Its atomic weight has been determined and the value is near 180.

In the references to hafnium, Prof. Stewart makes no mention of the several important communications from Coster and Hevesy, and Hevesy and Jantzen, which have appeared in the *Chemical News*.

Varieties of active hydrogen and nitrogen have been prepared recently. Active hydrogen appears to be triatomic since contraction occurs during its preparation, on that account has been termed *hyzone*. It reduces sulphur, arsenic, potassium permanganate, and other substances. It is changed into diatomic hydrogen by catalysts like platinum and nickel, although contact with a number of metals does not affect it. Strutt's active nitrogen reacts with phosphorus vapour, sulphur, and many metals when warmed, with the formation of nitrides. Much work has been done recently upon the hydrides and most of this receives adequate and careful treatment in the volume under review, but the author seems unaware of the existence of the solid hydrides or arsenic, antimony and bismuth, whose modes of preparation have been described during the last few years in this Journal, the *Transactions of the Chemical Society*, and the *Recueil de Travaux chimiques des Pays-Bas*.

Whilst reference, and perhaps emphasis, has been laid upon some of the omisions in Prof. Stewart's *Recent Advances*, it should be pointed out that these scarcely detract from its great value. Much important matter contained within the 300 odd pages cannot be mentioned, even in a lengthy notice, but it is hoped that sufficient has been said to indicate that the book includes the results of researches over the whole field of Physical and Inorganic Chemistry.

Successive editions of Prof. Stewart's *Recent Advances* have enjoyed a considerable vogue, not only among college students, but among chemists generally, for they have become indispensable to all interested in recent work and progress in chemical science.

J. G. F. Druce.

THE LAW OF HEAT OF FORMATION.

By Hawksworth Collins, B.A. (Camb.).

This law was first published in the *Chemical News*, 1922, CXXV., 81. Since then a great many confirmations of it have appeared in the same periodical, but they are scattered abount in twenty-six papers, so that it seems advisable now to bring them all together (before continuing the demonstration for each element) in order that scientists may see that the law is true without any doubt whatever, being supported by an overwhelming number of facts.

The law is as follows :—

" The heat of formation of an element is proportional to the product of its change of volume and its atomic weight, there being two distinct series, the sodium elements and the sub-sodium elements."

Sub-sodium elements are those of atomic weight less than 22. Sodium elements are those of atomic weight greater than 22.

" Change of volume " means the difference between the combining volume and the original free volume. When the former is less than the latter, the H.F. is positive, and when the former is greater than the latter the H.F. is negative.

There is room for only one example of each case, but an extra one is given when considered necessary.

Table I. gives the original relative volume of each one of 82 elements, obtained by dividing the atomic weight (see Table IV.) by the theoretical specific gravity. The original volnmes required by the law for Ag and Al occur in alloys. For Cl, O and N the equivalent original volumes are given, *i.e.*, the volumes these elements would have in the free state if they were solid instead of gaseous. The original volumes obtained for Ba, Mg, Mn, K and

B, although not yet experimentally determined, are shown to be correct.

Table II. gives the relative volume of each atom in 90 molecules. The H.F. of each atom in Table II. is given in Table III., and these two Tables together with Table I. produce the law in Table IV.

The fact that a law has been discovered proves that the results of Tables I., II., and III. are correct.

TABLE 1.

	Element	Orig. Rel. Vol.	Theor. S.G.	Obs. S.G.	
(1)	As	15.68	4.78	4.71	Rettendorf
				4.91	Spring
(2)	Bi	21.29	9.82	9.82	Roberts
(3)	Ca	25.66	1.56	1.566	Matthiessen
				1.55	Jobin
(4)	Cd	12.88	8.655	8.655	11° Matthiessen
(5)	Co	6.78	8.702	8.71	Lampadius
				8.558	Bunsen
(6)	Cr	7.13	7.3	7.3	Bunsen
(7)	Cu	7.02	8.97	8.96	Berzelius
(8)	Fe	6.94	8.07	8.007	10° Schiff
				8.139	15°.5 Smith
(9)	Hg	14.65	13.584	13.584	16°.6 Stewart
(10)	La	22.24	6.15	6.15	Baskerville
(11)	Mn	6.94	7.925	8.013	John
				7.206	Brunner
(12)	Mo	11.11	8.64	8.636	Bucholz
				9.01	Chem. Kal.
(13)	Na	23.70	0.97	0.97	Troost
(14)	Ni	6.64	8.88	8.88	Arndtsen
(15)	Ni	6.925	8.52	8.477 – 8.713	Baumgartner
(16)	P (red)	14.56	2.129	2.106	Schrotter
				2.14	Brodie
(17)	P (yellow)	16.87	1.838	1.82 – 1.84	10° Schrotter
(18)	Pb	18.17	11.34	11.346	Crichton
				11.33	Kupfer
(19)	Pd	9.05	11.49	11.4	Deville
				11.628	Benneke
(20)	S (cryst.)	15.58	2.0605	2.063	Deville
				2.05	Karsten
(21)	S (amorp.)	17.15	1.87	1.87	Muller
(22)	Sb	17.91	6.65	6.646	Playfair
				6.675	Spring
(23)	Se	16.27	4.794	4.796	Schaffgotsch
(24)	Se	18.17	4.298	4.297	Schaffgotsch
				4.28	Rathke
(25)	Si	13.83	2.025	2.004 – 2.194	Winkler
(26)	Sn	16.02	7.37	7.373	Deville
(27)	Ta	18.106	10.05	10.08	Rose
(28)	Te	20.55	6.229	6.229	40° Spring
				6.015	20° Nostrand
				6.27	Nostrand
(29)	Ti	13.69	3.506	3.5	Chem. Kal.
				3.543	Nostrand
(30)	Tl	17.3	11.80	11.81	Crookes
				11.77	Werther
(31)	V	9.05	5.685	5.5	15° Roscoe
				5.866	Setterberg
(32)	W	10.04	18.32	18.26	Uslar
				18.447	Zettrow

(33)	Zn	9.85	6.60	6.55 6.861	Roberts Brisson
(34)	Zr	18.59	4.841	5.3 4.15	Nostrand Troost
(35)	Ag_4Sn 4(9.78) + 16.02		9.9	9.95	15° Holzmann
(36)	$AgSn_3$ 9.78 + 3(16.02)		7.97	7.936	19° Holzmann
(37)	$AlCu_5$ 9.05 + 5(7.02)		7.746	7.727	Hirzel
(38)	$AlCu_4$ 9.05 + 4(7.02)		7.514	7.534	Hirzel
(39)	I (liq.) 31.74 = ½(30.24 + 33.24)		4.000	4.004	107° Billet
(40)	Ba	29.0			
(41)	Cl	28.41 (Equivalent Orig. Vol.)			
(42)	K	29.39			
(43)	Mg	27.71			
(44)	Mn	11.58			
(45)	B	11.85			
(46)	C	3.44	3.49	3.492	Grailich (diamond)
(47)	C	5.436	2.21	2.229	Kenngott (graphite)
(48)	C	6.544	1.884	1.84 1.80	Griffith Playfair
(49)	Li	13.11	0.534	0.534	20° Nostrand
(50)	O	10.07 (Equivalent Orig. Vol.)			
(51)	N	1.707 (Equivalent Orig. Vol.)			

TABLE II.

Molecule.	Rel. Vol. of each Atom.	Theor. S.G.	Obs. S.G.	
(1)	As_2O_3 2(19.58) + 7.53 + 2(2.51)	3.83	3.85	Claudet
(2)	Bi_2O_3 2(24.29) + 3(2.51)	8.3	8.5 8.21	Dumas Herapath
(3)	CaO 14.54 + 2.51	3.28	3.25 3.32	Brugelmann Levallois
(3A)	CaO 13.25 + 4.45	3.164	3.161	Karsten
(4)	CdO 15.16 + 2.51	7.19	8.11 6.95	Werther Karsten
(4A)	$CdCl_2$ 11.76 + 23.01 + 15.085	3.651	3.655	16°.9 Knight
(4B)	CdI_2 14.73 + 2(27.75)	5.2	5.543 4.576	Kebler 10° Bodeker
(5)	CoF_2 11.56 + 2(5.42)	4.33	4.43	Nostrand
(6)	Cr_2O_3 2(8.71) + 3(2.51)	6.09	6.2 5.21	Schiff Wohler
(6A)	Cr_2O_3 2(8.71) + 2(2.51) + 4.45	5.65	6.2 5.21	Schiff Wohler
(7)	Cu_2Se 2(9.54) + 11.31	6.71	6.71	Nordenskiol
(8)	FeS 6.94 + 10.51	5.04	5.035	Playfair
(8A)	Fe_3C 3(6.4) + 5.69	7.235	7.07 7.396	16° Nostrand Interntl.
(8B)	$FeSiO_3$ 10.08 + 17.61 + 3(2.51)	3.748	3.713	Gruner
(8B)	Fe_2O_3 2(10.08) + 2(4.45) + 2.51)	5.07	5.079	Neumann
(8B)	Fe_3O_4 3(10. 08) + 2(2.51 + 4.45)	5.25	5.25	Gorgeu
(8C)	Fe_3O_4 3(11.64) + 3(2.51) + 4.45	4.94	4.96	Gerolt
(8D)	$Fe_2(SO_4)_3.9H_2O$ 2(17.22) + 3(15.53) + 6(7.53) + 6(2.51) + 9(14.03)	2.10	2.1	Dana
(9)	HgS 14.65 + 15.58	7.654	7.552 – 7.701	Moore
(9A)	HgBr 15.53 + 23.09	7.22	7.307	Karsten
(9B)	HgI_2 (red) 16.60 + 2(27.75)	6.29	6.2989	20°/20 Nostrand
(9C)	$HgCl_2$ 17.09 + 2(15.085)	5.72	6.223 5.42	Playfair Boullay

(9D) HgO 17.85 + 2.51	10.56	11.0	Boullay
(10) $LaCl_3$ 16.89 + 3(15.085)	3.95	3.947	18°/4 Nostrand
(11) MnO_2 7.13 + 7.53 + 2.51	5.07	5.04	Dana
(12) MoO_2 15.53 + 2(2.51)	6.23	6.44	16° Monro
		5.67	Bucholz
(13) Na_3AsO_4 3(11.85) + 19.58 + 7.53 4.45 + 2(2.51)	2.88	2.86	21° Stallo *i.e.*, 2.875 15°
(13) $Na_3AsO_4.12H_2O$ 3(11.85) + 19.58 + 7.53 + 4.45 + 2(2.51) + 12(14.03)	1.763	1.762	Schiff
(13) Na_2CO_3 2(11.85) + 8 + 7.53 + 2(2.51)	2.40	2.407	Favre
(13) $NaHCO_3$ 11.85 + 5.76 + 8 + 7.53 + 2(2.51)	2.201	2.205	Schroder
		2.192	Playfair
(14) Ni_2O_3 2(11.53) + 2(4.45) + 2.51	4.814	4.814	Playfair
(14A) NiO 8.065 + 4.45	6.0	5.597	Playfair
		6.398	Bergemann
(14B) NiS 6.64 + 10.51	5.306	4.601	Kenngott
		5.65	Rammelsberg
(15) $NiSO_4$ 8.065 + 15.53 + 2(7.53) + 2(2.51)	3.55	3.526	Playfair
		3.643	16° Pape
(16) $Na_3PO_4.12H_2O$ 3(11.85) + 16.87 + 3(2.51) + 4.45 + 12(14.03)	1.63	1.622	Playfair
(16A) $BaH_4P_2O_4.H_2O$ 23.98 + 4(5.76) + 2(14.56) + 4(2.51) + 14.03	2.834	2.839	Schroder
(17) KH_2PO_4 18.05 + 2(5.76) + 14.56 + 4.45 + 3(2.51)	2.424	2.403	Buignet
(17A) H_3PO_3 5.76 + 2(8.59) + 16.87 + 3(2.51)	1.67	1.651	21°.2 Thomsen
(18) PbO 17.42 + 7.53	8.90	8.74 - 9.09	Geuther
(18A) $PbCl_2$ 19.44 + 2(15.085)	5.58	5.68	Karsten
		5.29	Monro
(18B) $PbCO_3$ 19.81 + 8.0 + 7.53 + 2(2.51)	6.59	6.60	Smith
		6.5	John
(19) K_2PdCl_6 2(18.05) + 15.1 + 6(15.085)	2.8	2.806	Topsoe
(20) $CaSO_4$ 13.25 + 15.53 + 2(7.53 + 2.51)	2.784	2.759 - 2.884	Schroder
(21) $Fe_2(SO_4)_3.9H_2O$ 2(17.22) + 3(15.53) + 6(7.53) + 6(2.51) + 9(14.03)	2.10	2.1	Dana
(22) Sb_2O_3 2(21.29) + 2(2.51) + 4.45	5.5	5.566	Mohs
		5.251	Playfair
(23) Cu_2Se 2(9.54) + 11.31	6.71	6.71	Nordenskiold
(23A) Se_2Cl_2 17.43 + 21.29 + 23.01 + 15.085	2.95	2.906	17°.5 Divers *i.e.*, 2.914 15°
(24) PbSe 17.42 + 18.86	8.00	8.10	15° Nostrand
(25) SiO_2 17.61 + 2(2.51)	2.651	2.651	Breithaupt
(25A) $CaSiO_3$ 13.25 + 18.91 + 3(2.51)	2.923	2.919	18° Nostrand
(25B) SiC 7.13 + 5.69	3.12	3.12	15° Nostrand
(26) SnO 18.04 + 2.51	6.51	6.6 - 6.45	0° Ditte
(26A) SnO_2 16.02 + 2(4.45)	6.019	6.019	(artif.) Leeds
(27) Ta_2O_5 2(22.17) + 5(2.51)	7.805	7.653 - 7.986	Rose
(28) $BaO.TeO_3$ 24.58 + 4.45 + 20.55 + 3(7.53)	4.545	4.5486	10°.5 Clarke
		4.5305	10° Clarke

(28) BaO 24.58 + 4.45	5.23	5.32	Brugelmann
		4.986	Playfair
(29) $Sr_2Ti_3O_8$ 2(19.56) + 3(9.44) + 8(2.51)	5.12	5.1	Bourgeois
(30) $TlAl(SO_4)_2.2H_2O$ 18.05 + 9.05 + + 2(15.53) + 4(7.53) + 4(2.51) + 2(14.03)	3.631	3.647	17° Pettersson
(30) $Tl_2Zn(SO_4)_2.6H_2O$ 2(18.05) + 14.73 + 2(15.53) + 4(7.53) + 4(2.51) + 6(14.03)	3.75	3.72	20° Tutton
(31) V_2O_5 2(17.76) + 7.53 + 4(2.51)	3.43	3.357	18°/4 Nostrand
		3.47	20° Schafarik
(32) WO_2 12.81 + 2(2.51)	12.11	12.11	Karsten
(33) ZnF_2 11.76 + 2(5.42)	4.557	4.556	17° Clarke
(33) ZnO_2H_2 11.76 + 7.53 + 2.51 + 2(5.76)	2.97	3.06	Filhol
		2.68	Nickles
(34) ZrO_2 15.59 + 2(4.45)	4.98	4.9	Berlin
		5.0	Nostrand
(35) $AgNO_3$ 13.29 + 3.8 + 3(7.53)	4.26	4.253 – 4.27	Schroder
(37) $AlCl_3$ + $3C_6H_6$ 12.05 + 3(15.085) + 3(89.7)	1.126	1.14	0° Gustavson
		1.12	20° Gustavson
(37) C_6H_6 89.7	0.87	0.8773	20° Naumann
		0.85	15°.5 Faraday
(37) Al_2Cl_6 + $3C_{10}H_{14}$ 2(12.05) + 6(15.085) + 3(157.65)	1.139	1.139	0° Gustavson
		1.127	18° Gustavson
(37) $C_{10}H_{14}$ (cymene) 157.65	0.85	0.857	16° Noad
(39) CuI 9.54 + 27.75	5.095	5.7	Rodwell
		4.41	Schiff
(39A) KI_3 22.29 + 3(32.77)	3.465	3.498	15° Nostrand
(40) $BaCl_2$ 23.98 + 2(15.085)	3.82	3.82	Schiff
(40A) $BaSiO_3$ 24.58 + 13.83 + 4.45 + 2(2.51)	4.43	4.44	18° Nostrand
(40B) BaO 25.66 + 4.45	5.05	4.986	Playfair
		5.32	Brugelmann
(41) $MnCl_2$ 11.53 + 2(15.085)	3.022	2.977	25°/4 Baxter *i.e.*, 3.0 15°
(41A) Se_2Cl_2 17.43 + 21.29 + 23.01 + 15.085	2.95	2.906	17°.5 Divers *i.e.* 2.914 15°
(42) KF 22.29 + 5.42	2.093	2.096	21°.5 Clarke
(42A) K_2S 2(18.05) + 15.53	2.130	2.130	Filhol
(42B) K_2CO_3 21.42 + 22.29 + 8 + 7.53 + 2(2.51)	2.15	2.103	Playfair
		2.267	Filhol
(42C) $KHCO_3$ 21.42 + 5.76 + 8 + 7.53 + 2(2.51)	2.095	2.092	Playfair
(42D) KOH 18.637 + 4.45 + 5.76	1.941	1.958	Smith
(43) $MgCO_3$ 7.51 + 8 + 7.53 + 2(2.51)	2.994	2.9 – 3.1	Chem. Kal.
(43A) MgF_2 8.71 + 2(5.42)	3.17	3.15	Sella
(43B) $MgCl_2$ 14.565 + 2(15.085)	2.18	2.177	Playfair
(44) (44A) Mn_3O_4 13.02 + 2(11.53) + 2(4.45 + 2.51)	4.58	4.325	Playfair
		4.653	Playfair
(44) $MnSO_4$ 13.02 + 15.53 + 2(7.53 + 2.51)	3.1	3.1	14° Bodeker
(44A) $MnCO_3$ 11.53 + 8 + 7.53 + 2(2.51)	3.585	3.592	Mohs
		3.553	Karsten

(45)	$Na_2B_4O_7$ 2(11.85) + 2(15.7 + 3.85) + 7.53 + 6(2.51)	2.366	2.367	Filhol
(46)	SiC 7.13 + 5.69	3.12	3.12	15° Nostrand
(47)	Fe_3C 3(6.4) + 5.69	7.235	7.07	16° Nostrand
			7.396	Interntl.
(48)	Na_2CO_3 2(11.85) + 8 + 7.53 + 2(2.51)	2.40	2.407	Favre
(49)	LiF 5.46 + 5.42	2.39	2.295	21° Clarke
			2.54	Chem. Kal.
(49A)	$Li_2SO_4.H_2O$ 2(6.21) + 15.53 + 2(7.53) + 2(2.51) + 14.03	2.062	2.052	20°/4 Nostrand
(50)	PbO 17.42 + 7.53	8.90	8.74 - 9.09	Geuther
(50A)	CaO 13.25 + 4.45	3.164	3.161	Karsten
(50B)	SiO_2 17.61 + 2(2.51)	2.651	2.651	Breithaupt

Tables 3 and 4 and Summary Next Week.

SCIENTIFIC WORK OF PROFESSOR MONROE, GEORGE WASHINGTON UNIVERSITY.

Under the title of "A Half Century in Chemical Education," Professor J. N. Taylor contributes an interesting article to the current issue of *General Science Quarterly*.

Charles Edward Munroe was born at Cambridge, Massachusetts, on May 24, 1849. He was graduated from Harvard in 1871, receiving the S. B. degree, *summa cum laude*. In 1871 he was appointed Assistant in Chemistry, under Professor J. P. Cooke, who was head of the department. Munroe was given full charge of the course in Quantitative Analysis for Seniors, which he carried on independently for three years. He also conducted a course in wet Assaying.

In 1874 he was appointed Professor of Chemistry at the U.S. Naval Academy, holding that chair for twelve years, until in 1886 he was called to the Naval Torpedo Station at Newport, Rhode Island. From 1886 until 1892 he was engaged in chemical activities at the Torpedo Station and the Naval War College. From 1892 to 1917 he was head professor of chemistry at George Washington University; acting from 1892 to 1898 as dean of the Corcoran Scientific School, and from 1893 to 1917 as dean of the School of Graduate Studies, which he originated. Since 1917 he has been dean emeritus of the School of Graduate Studies and Professor emeritus of chemistry of George Washington University. He received from this University the Ph.D. and LL.D.

Professor Munroe's graduating thesis at Harvard was on analytical methods and apparatus, and throughout his career this topic has appealed to him. He has published many articles in this field and has devised many pieces of apparatus which have come into more or less general use, and all have been of value. Among them may perhaps be noted his Porous Cone, in the making of which he developed a new principle for the production of fine and uniform pores throughout a biscuit of plastic matter by incorporating within the plastic mass, before the matter was shaped and burned, a volatile substance, preferably ammonium chloride. This porous material was subsequently extensively used for biochemical filtrations in the Pasteur-Chamberland filter. In the development of the application of Porous Cones to Filtration by the use of the Sprengel pump, which had recently been introduced for the production of reduced pressures, he devised the Rubber Gasket by which the cones could be hermetically connected with the filter pump by an elastic seal.

Following his invention of a method for the production of a porcelain biscuit of uniformly fine porosity, Professor Munroe applied this to the production of refrigeration by the use of water only, thus eliminating the use of ice. His prime object was to apply this method to refrigerator cars, where the motion, when the cars were under way, would promote evaporation and consequent cooling, but he also applied the method to household refrigerators, in which by the use of water only, he secured temperatures as low at 56° F. in the hottest weather. Under the title, "Improvement

in Refrigerators," he was granted U.S. Patent No. 116,844, on June 27, 1872. To those skilled in the art, it is obvious that this device was a descendant from the well-known "water monkey," and, therefore, based on a well proven principle of action.

The late Professor Chandler characterised his work on "Chemicals and Allied Products" as "invaluable." He considered it "the most valuable publication to a chemist that has ever emanated from the Census Bureau," and as one that would "never lose its value to the chemical profession." Professor Munroe's monograph on "Petroleum" is said to be one of the most exhaustive reports ever issued on the subject. The value of these reports as aids in chemical education has recently been pointed out by Professor Mattern.

Since its inception, Professor Munroe has been connected with the National Research Council as Chairman of the Committee on Explosives Investigations, conducting, in this capacity, much valuable work, among which may be mentioned that on ammonium nitrate. He is also Chief Explosives Chemist to the Bureau of Mines and was one of its active organisers. In addition to these duties, he is prominently engaged in consulting work for the Assay Commission, the Civil Service Commission, and as consulting expert to the War and Navy Departments. He was retained for many years by the Aetna Powder Company and has been engaged in a similar capacity by at least ten governments.

Professor Munroe's scientific contributions to the *Chemical News*, and the literature of chemistry generally, testify eloquently to the inestimable service which he has rendered to his profession.

(Abstracted from *General Science Quarterly*, March, 1926, pp. 479-491.)

General Notes.

Graphite mining in Canada is recovering from the depression from which it has suffered for some years. The industry is being established on a more healthy and favourable basis, and promises well for the future. The Black Donald Mine at Calabogie, Ontario, and the Standard mine at Guenette, Quebec, finding a ready market for their products, are producing to the full capacity of their concentrating plants. The Black Donald is marketing the greater part of its product in the United States, the Standard in Germany and in England.

The present activity is due to higher prices for flake in the United States market and to possibilities of increased trade with Europe. Canadian operators have the stability of Canadian credit as an inducement to European trade. The greater development of this trade, and the continued support of European buyers will enable Canadian operators to furnish a dependable supply of high quality graphite.

CUBA.—GENERAL FEELING OF OPTIMISM.

In his report on Cuba dated November last, Mr. M. H. C. Kelham, Acting British Consul-General at Havana, writes that the commercial and political atmosphere of Cuba to-day seems to be impregnated with a general feeling of optimism in spite of the very low market value of sugar. The new President came into office on 20 May, 1925. Considerable plans for the improvement of the country are proposed, and present every likelihood of being carried out. The Public Works Law was passed on 15th July, 1925, providing, among many improvements, the building of a great central highway from one end of the island to the other, with branches connecting it with all the towns and ports along the coast. The necessity for this road from every standpoint is very apparent. It will be a means of obtaining better transport facilities for the sugar products and Cuba's sources of wealth, which, up to the present have been inaccessible, and will be placed on the market, thereby giving a great impetus to commerce. It will also give employment over a period of several years to many who are suffering from the general trade depression.

INFLUENCE OF IONS ON EMULSIONS.

1. It is shown that an oil emulsion closely resembles a colloidal suspension, and the generalisations advanced for a sol is followed by an emulsion.

2. The separation of oil-in-water emulsion into two layers can be regarded as the coagulation of the dispersed oil globules. The reversal of phase of oil-in-water is prob-

ably the dispersion of water particles carrying a positive charge in the oil.

3. From the experimental results of various workers it is concluded that salts like NaCL, KCl, Na citrate, NaOH, etc., favour the formation of an emulsion of the type oil-in-water. This shews that anions, *viz.*, Cl′, Cit‴, OH′, etc., are appreciably absorbed by the oil globules.

4. It has been deduced that the adsorption of the anions is mainly responsible for the antagonism observed between the electrolytes of mono-valent cations like NaCl, KCl, NaOH, etc., towards salts of bivalent and trivalent cations like $Ba(NO_3)_2$ $AlCl_3$, $Al_2(SO_4)_3$, etc., on the inversion of an oil emulsion.—(S. Ghosh and N. R. Dhar in *Journal of the Franklyn Institute.*)

AMERICA DEPENDANT ON EUROPE FOR POTASH.

The *Christian Science Monthly* refers in a recent issue to the report on the subject issued by the U.S.A. Department of Agriculture, which shews that Alsace and Germany supply most of the potash used in the U.S.A. The Potash Agreement of 1924 is described as "unique in the history of international relations," for the following reasons: 1—It involves a practical monopoly of an essential raw material; 2—It applies to sales in the United States alone; 3—One of its signatories is a state (Alsace(and the other represents an industry under the complete control of the German Government.

Up to 1914, 99 per cent. of American potash imports originated in Germany. Inquiry at the Department of Agriculture shows that the United States pre-war requirements of crude potash salts averaged approximately 1,000,000 tons. During the war when potash supplies were cut off the price jumped from around $50 a ton to $500 a ton. At present the United States takes approximately 23 per cent. of the world's production.

In formulating the German potash agreement, the producers calculated the American consumption at 200,000 metric tons, of which Alsace was to supply 68,500 tons and Germany 131,500. Should American consumption exceed this figure the same proportions were to be preserved. The price was fixed at $27 per ton of 80 per cent. chloride of potash, it is explained.

Of the importance of potash, the report says: "It is as a plant food that potash becomes absolutely indispensable in the economic welfare of this country, for without it agriculturists cannot adequately meet the food requirements of a continuously growing population." It adds: "The importance of potash as a fertiliser is emphasisesed by the fact that it, similar to phosphate, is a plant food found in virgin soil which, when exhausted by cultivation, is not replaced by nature; hence the urgency for continuously supplying it artificially."

The report, which is of an exhaustive character, urges that the potash beds recently discovered in Texas and supposed to be of great area, should be explored as an alternative source of potash.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read at the meeting held on Thursday, March 26:—

The Effects of Ultra-Violet Radiation upon the Metabolism of Healthy Subjects. By J. A. Campbell. Communicated by Dr. Leonard Hill, F.R.S.

(1) Radiation by total rays (223-770 $\mu\mu$) from the mercury-vapour lamp, or by the group of rays through blue uviol glass (290-436 $\mu\mu$), or by the visible rays from either of these sources (400-770 $\mu\mu$ and 400-436 $\mu\mu$ respectively) has no effect upon the metabolism of healthy men, mice or rats.

(2) When mice lie together in groups there is apparently a decrease of CO_2 output due to reduction of surface area.

(3) A simple and handy method of estimation of CO_2 output and O_2 intake in small animals is described.

A Study of Certain Forms of Inhibition and Acceleration of Hæmolysis. By E. Ponder. Communicated by Sir E. Sharpey Schafer, F.R.S.

This paper is concerned with the development of a method for dealing with hæmolytic systems which contain substances which produce acceleration or inhibition. Four types of such effect are recognised: (1) the inhibition produced by plasma and serum, described by expressions which suggest an interaction between the plasma or serum

and the lysis, not unlike those which occur in adsorption processes; (2) the inhibition produced by certain bases, sugars and neutral salts, which are described by linear expressions; (3) the acceleration produced by acids and by certain salts, also described by linear expressions; and (4) the acceleration produced by plasma or serum when added to a hæmolytic system in which the lysis is one of the bile salts or soaps.

The first of these types has already been dealt with (1, 2), and this paper deals with types 2, and 3, which are the most generally met with. Type 4 remains to be considered.

With regard to types 2 and 3, the expressions necessary for their description are given, and the meaning of the constants therein considered. The object of the study being to investigate the kinetics of such hæmolytic systems, little attention has been paid to the possible ways in which the accelerating or inhibiting substances may bring about their effects, the only observation of note in this connection being that in the case of substances whose reaction is not a neutral one, the effect is not wholly dependent on the pH.

The Isolation of Some Undescribed Products of Hydrolysis of Proteins. By S. B. Schryver and H. W. Buston. Communicated by Sir John Farmer, F.R.S.

From the hydrolysis products of one of the oat proteins (of which a new method of preparation is given) two hitherto undescribed amino-acids have been obtained. They were isolated by means of the authors' "carbamate method," and were found in the non-basic fraction of the soluble barium carbamates. These latter can, by means of the zinc salts, be separated into three main fractions: (*a*) a fraction (zinc salts) only slightly soluble in cold water, and yielding only leucine; (*b*) a fraction easily soluble in cold water, but insoluble in alcohol, yielding chiefly alanine and valine; (*c*) a fraction easily soluble in both cold water and alcohol. The last-named contained two amino-acids which could be separated by taking advantage of the fact that one gave a copper salt insoluble in methyl alcohol and the other a copper salt soluble in this solvent. The former has a formula corresponding with hydroxyaminobutyric acid, $C_4H_9O_3N$, and gave a dibenzoyl compound, m.p. 112°, and a phenylisocyanate compound, m.p. 143°.

The other amino-acid has a formula corresponding with hydroxy-valine, $C_5H_{11}O_3N$, and gave a dibenzoyl compound, m.p. 117°, and a phenylisocyanate compound, m.p. 145°.

There is evidence of the presence of other undescribed substances among the hydrolysis of the oat proteins.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The Applications of Machinery at the Coal Face. By Sam Mavor, Member.

Summary.

The necessity for reduction in the cost and price of coal is considered, and the use of labour-saving machinery in the primary processes of winning coal is indicated as the most effective means by which the high labour cost can be substantially reduced.

The evolution and early history of coal-cutters are outlined, the later developments of these machines are indicated, and the leading characteristics of the bar, chain and disc coal-cutters are detailed.

The nature of the service required of coal-cutters is explained, and the conditions under which the service is rendered are defined.

Conveyors for underground use are described, and an outline is given of their place in the practice of intensive mining; first, in increasing the output per man at the coal face, and second, as an aid to the reduction of the cost of transport of the coal from site to the mechanical haulage.

An endeavour is made to indicate the respective spheres of electricity and compressed air for actuating coal-face machinery.

After a fairly exhaustive review, the author arrives at the following conclusion:

It must be accepted that electricity will continue to be excluded from the coal face iu many collieries, but the number of these may be reduced by fuller knowledge by mining men of the characteristics of mining electrical appliances and of the conditions essential to securing and maintaining the highest degree of safety in their use, and by fuller knowledge by electrical men of the conditions of service of coal-face machinery and other in-bye electrical apparatus and of the rough nature of the treatment to which it is unavoidably subjected.

Practice of the intensive methods of mining, rendered possible by coal-face machinery, has a bearing on the permissi-

bility of the in-bye use of electricity. The reduced pit room, the less surface of exposed gas-bearing coal, the diminished number, increased area, and improved maintenance of the air ways, and reduction of air leakages between intakes and returns, are all favourable to more effective ventilation ,and therefore to safety in the use of electricity. On the other hand, the more rapid advance of the workings may in some gaesous seams liberate so much gas as to exclude electrical appliances at the face. This also applies to seams liable to the occurrence of sudden outbursts of gas, and to places in the working of normal seams where accumulation of gas may be difficult to avoid.

Where such ventilation can be provided that explosive mixtures of gas and air are prevented, it is clear that electricity may be used with impunity. The measure of the risk that may attend the use of electricity is the degree to which the ventilation falls short, or may fall short, of the standard indicated above; in some seams that standard may be unattainable, in others attainable with difficulty. As already remarked, the mine manager, on whom the responsibility rests, has in every case the sole right to decide whether electricity shall or shall not be used. Generally, intensive mining by promoting effective and economical ventilation should, to the extent t does so, also promote the adoption of electrically-driven coal-face machinery.

The flame-proof enclosure of electrical apparatus is not designed for normal conditions of working, for the Regulations require that the men shall be withdrawn if the proportion of gas in the air reaches a figure which is much below the lower limit of danger of ignition. The purpose of flame-proof enclosure is to safeguard against any accidental or unexpected rise in the proportion of gas in the air, such as might be ignited by open sparks. A defect in design or maintenance that might destroy the flame-proof properties of an electric machine or appliance, need not, and probably would not, affect normal working under normal conditions, and this renders the more necessary the periodic careful examination and maintenance of flame-proof apparatus. Assuming that apparatus is flame-proof when installed, the safeguard depends on maintenance of that state.

Everyone familiar with underground conditions knows the difficulty of securing adequate maintenance of underground electrical apparatus. It takes time to train the personnel, but experience is educating mining men in the necessity for due attention to this subject, and improvement is progressive. At large collieries with competent electrical staffs, adequate in number, very good standards of maintenance exist; only at such collieries is it wise to send underground delicate automatic devices which are only a snare if their condition and adjustments are not properly maintained.

Coal-mining has greatly profited by the versatility of the electrical engineer, and by the high standard of quality, both electrical and mechanical, of his products. In the main, the sphere of electricity underground will continue to be in the secondary services—ventilating, pumping, hauling and winding. In application to the primary processes of mining at and near the coal face, the use of electricity is restricted; although increasing confidence in electricity may lead to some relaxation, it is certain that compressed air, displaced by electricity from important services at and near the shaft and in intake airways, will be very much more difficult to dislodge from the region of the coal face.

There are wide differences between mining operations and the work carried on in factories and workshops; many of the underground conditions and the forces to be dealt with are beyond control of the mining engineer, and they govern his plans of operation. Yet the special difficulties and vicissitudes to which mining is subject are mostly amenable to a considerable degree of control by methods appropriate to the conditions. Intensive mining facilitates control of the physical conditions, and further, it facilitates control and increases the productive effect of labour. Intensive mining on the unit system implies a considerable amount of standardisation of method, a cycle of operations at each unit of coal face is established, and several clearly defined operations are repeated in the same sequence day after day be men whose labour is specialised, and the work becomes comparable with some repetitive processes in workshops. These conditions render practicable the application to mining organisation and operations, of the principles that in recent years have so greatly increased the productivity of labour in other industries—notably in engineering.

The services of the mechanical and electrical engineer to the mining industry have been manifold, but abundant opportunity remains and the measure of it is the high cost of coal production. The output per underground worker is too low, therefore too many men are in the industry—that is why wages are low and costs are high. By mechanical and electrical aids to production the output per man can be raised, and the cost and price of coal can be reduced.

SOCIETY OF PUBLIC ANALYSTS

AND OTHER ANALYTICAL CHEMISTS.

An ordinary meeting of the Society was held at the Chemical Society's Rooms, Burlington House, on Wednesday, April 7, 1926, Mr. E. Richards Bolton, President, being in the chair.

Certificates were read for the first time in favour of Messrs. Arthur Barraclough, B.Sc., A.I.C., George Gordon Elkington, Kenneth Massy Griffin, M.Sc., A.I.C., Herbert Firth, A.I.C., and Thomas Pickerill, B.Sc.

Certificates were read for the second time in favour of Messrs. John Allan, Michael Thomas Casey, B.Sc., M.Sc., George Henry Davis, Julius Grant, M.Sc., A.I.C., and Miss Monica Mary Ruston, B.Sc., F.I.C.

The following were elected Members of the Society:—Messrs. Sydney Back, B.Sc., A.I.C., Howard Henry Bagnall, B.Sc., F.I.C., William Percival Crocker, Bernard William Alfred Crutchlow, B.Sc., A.I.C., Alec Munro Ferguson, M.A., B.Sc., A.I.C., Ralph Henry Klein, A.I.C., Oswald James Napier, M.A., A.I.C., George Stubbs, C.B.E., F.I.C., Joseph Hughes Williams, B.Sc., F.I.C., Kenneth Alan Williams, B.Sc., A.I.C.

The following papers were read and discussed:—

The Analysis of Acetic Anhydride. By H. Droop Richmond, F.I.C., and J. A. Eggleston, B.Sc.

By adding 2 c.c. of acetic anhydride to 200 c.c. of a mixture of 94 parts of toluene and 6 parts of aniline and measuring the rise of temperature produced in the reaction, a determination of the strength of the acetic anhydride can be made with an accuracy comparable to that of the method of Menschutkin and Wasilieff.

It is necessary in very accurate work to make a correction for the heat evolved in the formation of aniline acetate, but a very close approximation can be obtained by multiplying the observed rise of temperature by a factor.

The Analysis of Glacial Acetic Acid. By H. Droop Richmond F.I.C., and Eric H. England.

This paper contains a table showing the specific gravities and freezing points of glacial acetic acid for each 0.1 per cent. from 90 to 100.

Acetic acid is almost unique in that specific gravity falls with increasing percentage, whilst the freezing point rises. Impurities, of which propionic acid is the most important, lower both specific gravity and freezing point. By calculating the specific gravity from the table equivalent to the freezing point and subtracting from it the specific gravity found, a close approximation to the percentage of propionic acid can be obtained by dividing by 0.00135. Other impurities are aldehydes and ketones, probably chiefly propionaldehyde and homologues.

Errors of Judgment in Chemical Analysis. By J. F. Tocher, D.Sc., F.I.C.

Recent work of Professor K. Pearson and Mr. E. S. Pearson has shown that the mean values of personal judgment in physical experiments are of an irregular periodic character with respect to time. In the author's experiments on the titration of sodium hydroxide solutiou with *N*-sulphuric acid it was found that the mean results of successive determinations during a forenoon were also of a periodic character. On an average the first two determinations were less reliable than the others. The means of succeeding pairs of duplicate determinations also varied in an irregular and periodic manner round the general mean. The variations in the personal equations of observers were independent of the apparatus and the material.

Variations in the Composition of Milk. By J. F. Tocher, D.Sc., F.I.C.

The author has continued his study of the total quantity of the constituents of milk given, on an average, by an individual cow at each milking, and of the relationship of the casein to other factors. The percentage of butter fat tends to decrease slightly with increasing yield per milking, but the total amount of butter fat (and also of soilds not fat) increases proportionally with increased yield. The bearing of these facts on the problem of the selection of cows is discussed.

A Test for Tung Oil. By E. R. Bolton, F.I.C., and K. A. Williams, B.Sc., A.I.C. The authors suggest that previous attempts to obtain a definite and constant petroleum spirit extract of unpolymerised matter from the residue of Worstall's test have failed owing to incomplete and uncontrolled polymerisation. When the test is carried out under the conditions set forth a definite yield of extract varying between narrow limits is obtained, and, consequently, adulterants are readily disclosed by the yield of extract in excess of the standard amount. Most of the oils likely to be used as adulterants are completely recovered in the extract; linseed oil being an exception in which case approximately 50 per cent. is retained in the polymerised mass.

FORTHCOMING EVENTS

SOCIETY OF GLASS TECHNOLOGY.

The Ordinary General Meeting will be held in the Applied Science Department, The University, St. George's Square, Sheffield, on Wednesday, April 21, 1926, at 3 p.m.

The following papers will be read and discussed :—

"Note on the Devitrification of a Lead Borate Glass." By C. J. Smithells, D.Sc.

"Note on some Factors Governing the Resistance of Pots to Glass Attack." By J. F. Hyslop.

"The Detection of Small Amounts of Selenium in Glass." By J. D. Cauwood, M.Sc., and E. J. C. Bowmaker.

"Note on the Purification of Sand." By J. T. Howarth, M.Sc., and Prof. W. E. S. Turner.

The first and second papers are communications from the staff of the Research Laboratories of the General Electric Company, Ltd., Wembley.

GEOLOGICAL SOCIETY OF LONDON.

Burlington House, London, W.1.

The next meeting of the Society will be held on Wednesday, April 21, at 5.30 p.m., when the following communications will be read :—

"*Anthracopupa britannica* sp. nov., a Land Gastropod from the Keele Beds of Northern Worcestershire." By L. R. Cox, M.A., F.G.S.

"On *Bolopora undosa* gen. et sp. nov.: a Rock-Building Bryozoan with Phosphatized Skeleton from the Basal Arenig Rocks of Ffestiniog (North Wales)." By H. P. Lewis, M.A., F.G.S.

"The Geology of the Cayman Islands (British West Indies), and their Relation to the Bartlett Trough." By Dr. C. A. Matley, F. G. S.

Sir T. W. Edgeworth David, K.B.E., C.M.G., D.S.O., F.R.S., will exhibit lantern-slides illustrating the proposed new deep boring on the Great Barrier Reef, off Cairns (Queensland).

ROYAL INSTITUTION.

21, Albemarle Street, London, W.1.

Friday, April 16, at 9 p.m. "The Quest for Economic Plants." By Dr. A. W. Hill.

Saturday, April 17, at 3 p.m. "The Shipworm." By Dr. W. T. Calman.

Tuesday, April 20, at 3 p.m. "Organs of Multiple Function. II. The Spleen," By Prof. Joseph Barcroft, F.R.S.

Thursday, April 22. Anglo-Norman Lecture. By Oliver H. Prior, M.A.

Friday, April 23, at 9 p.m. "Luminous Discharge Through Rare Gases." By Prof. R. Widdington.

ROYAL SOCIETY OF ARTS.

John Street, Adelphi, London.)

Cantor Lectures.

Charles Reed Peers, C.B.E., M.A., Director, S.A., Chief Inspector of Ancient Monuments, H.M. Office of Works, "Ornament in Britain." Three Lectures, April 19, 26, and May 3.

Lecture I.—Definitions. The value and intention of ornament. Prehistoric ornament. Bronze Age. Hallstatt and La Tène. Classic and barbarian art. Lines of communication. Trade and invasion. The Roman conquests. Late-Celtic Art.

Lecture II. — Roman Britain. The northern invaders. The Christian Mission. Iona and Northumbria, Benedict Biscop and Wilfrid. Offa of Mercia. Alcuin and Charlemagne. The classic revival. The Danes. The Norsemen. Alfred. Athewold and the School of Winchester.

Lecture III.—Edward the Confessor, and the Normans. The Norman Conquest. English Romanesque. The evolution of

Gothic art and its use of ornament. The high-water mark. The decline.

Wednesday, April 21, at 8 p.m. Ordinary Meeting. Major-General Sir George McMunn, K.C.B., K.C.S.I., D.S.O., "Some Aspects of the Business Side of an Army."

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

8,100.—American Magnesium Corporation.—Refining calcium and magnesium. March 24th.

8,311.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of aralkylamines, etc. March 26th.

8,006.—I. G. Farbenindustrie Akt.-Ges. —Preparation of medicaments. March 23rd.

8,336.—Kendall, S. W.—Recovery of tin from tin-bearing materials. March 27th.

8,381.—Toniolo, C. — Manufacture of nitric acid. March 27th.

Specifications Published.

248,811.—Farbenfabrik vorm. F. Bayer & Co.—Manufacture of soluble vat dyestuff preparations.

240,401.—Consortium Fur Nassmetallurgie. —Process for the production of lead compounds from ores metallurgical products waste products from chemical processes, and the like.

248,864.—Wallace, W. M.—Recovery of soda from its solution, and apparatus therefor.

249,001.—Synthetic Ammonia & Nitrates, Ltd., and Bramwell, F. H.—High-pressure joints.

249,039.—Karpen & Bros., S.—Manufacture of methylals.

246,937.—Purifying liquids.—Remfry, F. G. P., and Dunstan, A. E., Meadhurst, Cadbury Road, Sunbury-on-Thames.

Purifying mineral and tar oils.—Liquids, especially mineral oils, mineral oil distillates, distillates of coal tar shale oil, and other liquid hydrocarbons, are purified by treatment with mercuric sulphide. Freshly-precipitated mercuric sulphide is agitated with the liquid, or it is precipitated on a porous or other carrier or mixed with a porous inert material for treatment of the liquid by filtration. The sulphide may be used in conbination or in sequence with another contact substance. The liquid may be treated in the form of vapour or while the sulphide or liquid is heated. The Provisional Specification states that any metallic sulphide may be used.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25 ,Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

APEX.

467,045.—Fertilisers.—J. C. Whitney & Co., Eldon Street House, Eldon Street, London, E.C.2. March 31st.

MENFORMON.

467,043.—Chemical substances prepared for use in medicine and pharmacy.—Naamlooze Vennootschap Tot Bereiding Van Orgaan Preparaten Op Wetenschappelijken Grandslag, Oss, Holland. March 31st.

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467,382.—Chemical substances prepared for use in medicine and pharmacy.—Kay Bros., Ltd., St. Petersgate Mills, St. Petersgate, Stockport. March 31st.

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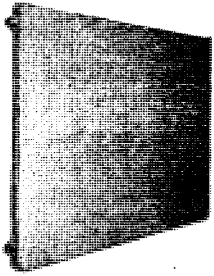

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Publisher's Announcements.

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THE GENERAL INDEX TO VOLS. 1 to 100 can still be purchased at £1 1s. (Carriage Paid.)

All communications should be addressed to the Manager, CHEMICAL NEWS.

THE CHEMICAL NEWS,

VOL. CXXXII. No. 3445.

MERTON HOUSE, SALISBURY SQUARE,
LONDON, E.C.4.
TELEPHONES :
Administrative : Central 6521.
Printing Works : Hop 2404.

A NOTE ON X-RAY TECHNIQUE.

By F. H. LORING.

An X-ray experiment involving a long exposure of 12 hours was made with rubidium chromate (Kahlbaum's) on the anticathode of a Shearer X-ray tube. A Müller spectrograph was used. The chromate was wetted with water and a drop of pure hydrochloric acid added. The anticathode was heated in a Bunsen flame when the compound was applied, being rubbed down hot so as to form an incrustation on the roughened copper surface. Owing to this coating on the anticathode, the copper lines were weakened. Only the following lines appeared :—

$CuK\alpha_2$, $CuK\alpha_1$, $CuK\beta_1$, $RbK\alpha_2$,
$RbK\alpha_1$, $RbK\beta_1$, and $RbK\beta_2$,

which was faint and not measured. The exposure was in the region silver absorption edge to the $CuK\alpha$ line. After the run the incrustation was still on the anticathode. All the lines on the plate were clear and sharp, but the bromine absorption edge was not properly defined. This may have been due to the bad condition of the cathode, as its surface requires constant attention.

The plate was remarakbly clear and free from fog except along one side, so that had there been any other radiations than indicated by the above lines, they would have produced visible lines if of appreciable strength considering the length of the exposure.

Faint lines can be clearly seen by holding the negative against a Northern sky, slightly overcast, and using a large magnifying glass to accommodate both eyes. Moderate magnification is sufficient.

PURE STEAM.

INTERESTING MODERN DEVELOPMENTS.

By A WELL-KNOWN ENGINEER.

Another section of steam boiler plant practice that is now attracting great attention is the purity of the steam, hitherto a much neglected subject. From a chemical point of view, steam as it issues from the boiler may contain small amounts of air and CO_2, while a common constitutent is ammonia, especialy when boiler compositions are used containing organic matter as a constituent. But the most objectionable impurities are " mechanical " in character, that is, free moisture, generally to the extent of 2-5%, and solid impurities such as iron rust, scale, dust, and oil, present in quite surprising amount, even when the feed water is of good quality and purified in a softening plant. All of these impurities mean a loss in one form or another, the free moisture, for example, representing an increase in the coal bill up to 5%, since heat is taken out of the plant not in the form of steam, and a lowering of the superheated steam temperature, the superheater having first to evaporate the moisture to steam. Also the disadvantages of dirty steam are obvious in the chemical and many different industries where the steam has to be blown direct into water or other liquids. Further troubles are the errosion of steam turbine blades and the cutting and scoring of piston rods and rings, liners, cylinders, and valves of steam engines, and solid particles carried over into the superheater are apt to give rise to " burning " of the tubes by lodging, and reducing the rate of heat transmission.

Messrs. The Power Auxiliaries Co., Ltd., of Marsden Street Manchester, have perfected a new steam separater and dryer, called the " Atlas,' which is of particular interest since it is claimed to eliminate all solid impurities and reduces the moisture content to less than 0.5%. The principle is essentially a light cast iron box placed inside the boiler, above the water space, attached to the steam discharge pipe. Generally there are two boxes, one on each side, connected underneath by a pipe, and these are completely closed except along both sides, which are built up of separate rows of narrow metal gutter baffles with a slit between. The steam has to pass through this nest of baffles on the way to

(42D)	K	50324	=	120	×	10.753	×	39	29.39	=	18.637	+	10.753
(43)	Mg	58260	=	120	×	20.2	×	24	27.71	=	7.51	+	20.2
(43A)	Mg	54760	=	120	×	19.0	×	24	27.71	=	8.71	+	19.0
(43B)	Mg	37858	=	120	×	13.145	×	24	27.71	=	14.565	+	13.145
(44)	Mn	- 9834	=	120	×	(- 1.49)	×	55	11.53	=	13.02	-	1.49
(44A)	Mn	0	=	120	×	0	×	55	11.53	=	11.53	+	0
(45)	B	69960	=	795	×	8.0	×	11	11.85	=	3.85	+	8.0
(45)	B	- 33668	=	795	×	(- 3.85)	×	11	11.85	=	15.70	-	3.85
(46)	C	- 21465	=	795	×	(- 2.25)	×	12	3.44	=	5.69	-	2.25
(47)	C	- 2427	=	795	×	(- 0.254)	×	12	5.436	=	5.69	-	0.254
(48)	C	- 13855	=	795	×	(- 1.456)	×	12	6.544	=	8.0	-	1.456
(49)	Li	42570	=	795	×	7.65	×	7	13.11	=	5.46	+	7.65
(49A)	Li	38416	=	795	×	6.9	×	7	13.11	=	6.21	+	6.9
(50)	O	32341	=	795	×	2.54	×	16	10.07	=	7.53	+	2.54
(50A)	O	71515	=	795	×	5.62	×	16	10.07	=	4.45	+	5.62
(50B)	O	96155	=	795	×	7.56	×	16	10.07	=	2.51	+	7.56
(51)	N	- 23300	=	795	×	(- 2.093)	×	14	1.707	=	8.8	-	2.093

Summary.

The large number of mathematical operations which have to be performed successfully in order that the law may be demonstrated will now be shown by taking No. 1 as an example.

(A) From the two approximate experimental data of S.G. discover the correct value (4.78) at 15° C.

(B) Divide the at. wt. by 4.78, obtaining the orig. rel. vol. of As (15.68) at 15° C.

(C) Discover the combining relative volume or volumes of As. This can only be done by a systematic study of all the thousands of substances of which the S.G. is recorded. (The volume of each atom in the molecule As_2O_3 is given at the top of Table II.)

(D) Discover the H.F. of each atom in this molecule. (The results in the case of As_2O_3 are given at the top of Table III.)

Discover the Law of H.F. by the following operations :—

(E) Subtract the combining volume of As from its original volume, obtaining - 3.9.

(F) Multiply this change of volume by the at. wt. 75 and by the constant for sodium elements (120), obtaining - 35100.

(G) Find the equivalent original volume of oxygen (10.07).

(H) Subtract the combining vol. of oxygen (7.53) from 10.07, obtaining 2.54.

(I) Multiply 2.54 by 16 and by the constant for sub-sodium elements (795), obtaining 32341.

(K) Subtract the other combining volume of oxygen from 10.07, obtaining 7.56.

(L) Multiply 7.56 by 16 and 795, obtaining 96155.

(M) Add the results (F), (I), and (L) as in No. 1, Table III., obtaining 154451, *which is considered to be correct if it* is within 2000 of the experimental result, 154670, because experimental results frequently differ by more than 2000.

This example demonstrates the exact manner in which the 90 experimental results of H.F. correspond with the experimental results of S.G.

Only 43 elements are available for the demonstration of this law, since the others are not included in the experimental determinations of H.F. 32 of the 43 are here employed. The remaining eleven, *viz.*, Pt, Au, Ce, Nd, Pr, Th, Sr, Be, Br, Cs and Rb, do not come into the demonstration at present, because *one of the necessary* experimental facts in each case is wanting.

It should be noticed that when an element has several combining volumes, these do not denote a weakening of the proof, but a very great strengthening, because each change of volume is shown to have a corresponding change of heat of formation.

Re Hydrogen, see the *Chemical News*, 1925, CXXXI, 83.

TESTS OF HOLLOW TILE AND CONCRETE SLABS REINFORCED IN ONE DIRECTION.

By Douglas E. Parsons and Ambrose H. Stang.

(*U.S.A. Bureau of Standards.*)

Beams which represented sections of typical combination hollow tile and concrete floor slabs reinforced in one direction were made and tested in the laboratory for the purpose of obtaining information on the value of hollow tiles in resisting bending and shearing stresses. The test pieces consisted of 42 beams from 8 feet 10 inches to 15 feet 3 inches long, all 8 inches in depth and having a maximum width of 30 inches. For the purpose of comparison two concrete beams having the same sectional area as the gross sectional area of the composite beams and three concrete beams having the same sectional area as the concrete ribs in the composite beams were also tested.

Observations were made of the deformation in the concrete, tiles and reinforcement,, deflection of the centre of the beam and development of cracks as the loads were applied.

Tables and curves give a summary of the test data, and comparisons are made between these and the usual design computations for reinforced concrete beams.

The results indicate that the tiles assisted the concrete in resisting both bending and shearing stresses. The assistance of the tiles in resisting bending stresses seemed to be approximately proportional to the modulus of elasticity of the tiles. The elasticity of the tiles in resisting shearing stresses varied somewhat with the kind of tile, but, in general, added about 50 per cent. to the shearing strength of each concrete rib.

Summary.

The results of these tests seem to warrant the following conclusions :—

For beams without topping.—1. In resisting bending stresses each hollow tile and concrete rib in the combination beams was equivalent in strength to a rectangular concrete beam having a width at least equal to the width of the concrete rib

$$\text{plus } 1.3\ (s+w)\frac{E_t}{E_c}$$

where E_c is taken as 2,000,000 lbs./in.^{2} and

s = thickness of one vertical tile shell, inches.

w = thickness of one vertical tile web, inches, and

E_t = modulus of elasticity of the tiles, lbs./in.^{2}

2. The average strength of the beams having mortar in the cross joints between the tiles was only slightly greater than the average strength of the corresponding beams having open joints.

3. The effect of the tiles at loads less than the maximum upon the deformations in the concrete, the position of the neutral axis, and the deflections was apparently equal to or greated than the effect of adding a width of concrete rib equal to $2\ (s+w)\frac{E_t}{E_c}$

4. The compressive stresses in the shells of the hard tiles in contact with the concrete ribs were greater than the compressive stresses in the adjacent concrete.

For beams with a topping.—The top shells of the tiles in contact with the concrete seemed to be as effective in resisting compressive stresses as an equal area of concrete in the same location.

For both types of beams.—On the assumption that the shearing resistance of the concrete in the combination beams was equal to its resistance in the concrete beams which failed by diagonal tension, the assistance of the two rows of half tile adjacent to each concrete rib was at least equivalent to the following widths of concrete in resisting shearing stress : Tile of lot 1, 2.2 inches; tile of lot 2 with mortar joints, 1.9 inches; tile of lot 3, 3.4 inches; tile of lot 3 with mortar joints, 2.5 inches; tile of lot 4, 2.4 inches.

2. The combination beams containing bent-up bars for web reinforcement resisted an average shearing stress over the $b'\ j_o d$ section of concrete of 541 lbs./in.^{2} without visible indications of diagonal tension failures.

3. The strength of the bond between the concrete and tiles even with open joints was sufficient to permit failures of the beams by compression and diagonal tension. There seemed to be no failures caused primarily by the failure of this bond.

(39A)	$KI.I_2$ 0 + 2(7010)	=	14020	13600	
(40)	$Ba.Cl_2$ 81926 + 2(56786)	=	195498	196880	
(40A)	$Ba.Si.O_3$ 72134 − 7728 + 71515 + 2(96155)	=	328231	328100	
(40B)	Ba.O 54500 + 71515	=	126024	126380	
(41)	$Mn.Cl_2$ 0 + 2(56786)	=	113572	111990	
(41A)	$Se_2.Cl_2$ − 10858 − 46987 + 23010 + 56786	=	21951	22150	
(42)	K.F 33228 + 76820	=	110048	110000	
(42A)	$K_2.S$ 2(53071) + 0	=	106142	103500	
(42B)	$K_2.C.O_3$ 37274 + 33228 − 13855 + 32341 + 2(96155)	=	281298	281100	
				282100	
(42C)	$K.H.C.O_3$ 37274 − 15300 − 13855 +32341 + 2(96155)	=	232739	233300	
(42D)	K.O.H. 50324 + 71515 − 15300	=	106539	104600	
(43)	$Mg.C.O_3$ 58260 − 13855 + 32341 + 2(96155)	=	269025	269900	
				266600	
(43A)	$Mg.F_2$ 54760 + 2(76820)	=	208400	208100	
				209500	
(43B)	$Mg.Cl_2$ 37858 + 2(56786)	=	151430	151010	
(44)	$Mn_3.O_4$ − 9834 + 2(0) + 2(71515 + 96155)	=	325506	324900	
				328000	
(44)	$Mn.S.O_4$ − 9834 + 0 + 2(32341 + 96155)	=	247158	249400	
(44A)	$Mn.C.O_3$ 0 − 13855 + 32341 + 2(96155)	=	210796	210300	
(45)	$Na_2.B_4.O_7$ 2(32706) + 2(69960) − 2(33668) + 32341 + 6(96155)	=	747267	748100	
(46)	Si.C 22512 − 21465	=	1047	1963	
(47)	$Fe_3.C$ 3(3629) − 2427	=	8460	8460	
(48)	$Na_2.C.O_3$ 2(32706) − 13855 + 32341 + 2(96155)	=	276208	273700	
				278280	*aq.*
(49)	Li.F 42570 + 76820	=	119390	120000	
(49A)	$Li_2S.O_4$ 2(38416) + 0 + 2(32341) + 96155)	=	333824	333500	
				334170	
(50)	Pb.O 18500 + 32341	=	50841	50800	
(50A)	Ca.O 59568 + 71515	=	131083	131500	
(50B)	$Si.O_2$ − 12701 + 2(96155)	=	179609	180000	

TABLE IV.

THE LAW OF HEAT OF FORMATION.

		Heat of Formation.							Orig. Vol.		Rel. Vol. in combination 15° C	Change of Volume
(1)	As	− 35100	= 120	×	(− 3.9)	×	75		15.68	=	19.58	− 3.9
(2)	Bi	− 75200	= 120	×	(− 3.0)	×	209		21.29	=	24.29	− 3.0
(3)	Ca	53376	= 120	×	11.12	×	40		25.66	=	14.54	+ 11.12
(3A)	Ca	59568	= 120	×	12.41	×	40		25.66	=	13.25	+ 12.41
(4)	Cd	− 31000	= 120	×	(− 2.33)	×	111		12.83	=	15.16	− 2.33
(4A)	Cd	14252	= 120	×	1.07	×	111		12.83	=	11.76	+ 1.07
(4B)	Cd	− 25308	= 120	×	(− 1.9)	×	111		12.83	=	14.73	− 1.9
(5)	Co	− 33842	= 120	×	(− 4.78)	×	59		6.78	=	11.56	− 4.78
(6)	Cr	− 9859	= 120	×	(− 1.58)	×	52		7.13	=	8.71	− 1.58
(7)	Cu	− 19080	= 120	×	(− 2.52)	×	63		7.02	=	9.54	− 2.52

(8)	Fe	0	=	120	×	0	×	56	6.94	=	6.94	+	0
(8A)	Fe	3629	=	120	×	0.54	×	56	6.94	=	6.4	+	0.54
(8B)	Fe	− 21101	=	120	×	(− 3.14)	×	56	6.94	=	10.08	−	3.14
(8C)	Fe	− 31570	=	120	×	(− 4.7)	×	56	6.94	=	11.64	−	4.7
(8D)	Fe	− 69149	=	120	×	(− 10.29)	×	56	6.94	=	17.23	−	10.29
(9)	Hg	0	=	120	×	0	×	199	14.65	=	14.65	+	0
(9A)	Hg	− 20890	=	120	×	(− 0.88)	×	199	14.65	=	15.53	−	0.88
(9B)	Hg	− 46590	=	120	×	(− 1.95)	×	199	14.65	=	16.60	−	1.95
(9C)	Hg	− 58600	=	120	×	(− 2.45)	×	199	14.65	=	17.10	−	2.45
(9D)	Hg	− 76416	=	120	×	(− 3.2)	×	199	14.65	=	17.85	−	3.2
(10)	La	92000	=	120	×	5.55	×	138	22.44	=	16.89	+	5.55
(11)	Mn	− 1254	=	120	×	(− 0.19)	×	55	6.94	=	7.13	−	0.19
(12)	Mo	− 50900	=	120	×	(− 4.42)	×	96	11.11	=	15.53	−	4.42
(13)	Na	32706	=	120	×	11.85	×	23	23.70	=	11.85	+	11.85
(14)	Ni	− 34590	=	120	×	(− 4.89)	×	59	6.64	=	11.53	−	4.89
(14A)	Ni	− 10040	=	120	×	(− 1.425)	×	59	6.64	=	8.065	−	1.425
(14B)	Ni	0	=	120	×	0	×	59	6.64	=	6.64	+	0
(15)	Ni	− 8065	=	120	×	(− 1.14)	×	59	6.925	=	8.065	−	1.14
(16)	P	− 8593	=	120	×	(− 2.31)	×	31	14.56	=	16.87	−	2.31
(16A)	P	0	=	120	×	0	×	31	14.56	=	14.56	+	0
(17)	P	8593	=	120	×	2.31	×	31	16.87	=	14.56	+	2.31
(17A)	P	0	=	120	×	0	×	31	16.87	=	16.87	+	0
(18)	Pb	18500	=	120	×	0.75	×	206	18.17	=	17.42	+	0.75
(18A)	Pb	− 31394	=	120	×	(− 1.27)	×	206	18.17	=	19.44	−	1.27
(18B)	Pb	− 40607	=	120	×	(− 1.64)	×	206	18.17	=	19.81	−	1.64
(19)	Pd	− 75500	=	120	×	(− 6.05)	×	104	9.05	=	15.10	−	6.05
(20)	S	0	=	120	×	0	×	32	15.53	=	15.53	+	0
(21)	S	6217	=	120	×	1.62	×	32	17.15	=	15.53	+	1.62
(21A)	S	19277	=	120	×	5.02	×	32	15.53	=	10.51	+	5.02
(22)	Sb	− 48200	=	120	×	(− 3.38)	×	119	17.91	=	21.29	−	3.38
(23)	Se	46380	=	120	×	4.96	×	78	16.27	=	11.31	+	4.96
(23A)	Se	− 10858	=	120	×	(− 1.16)	×	78	16.27	=	17.43	−	1.16
(23A)	Se	− 46987	=	120	×	(− 5.02)	×	78	16.27	=	21.29	−	5.02
(24)	Se	− 1778	=	120	×	(− 0.19)	×	78	18.17	=	18.36	−	0.19
(25)	Si	− 12701	=	120	×	(− 3.78)	×	28	13.83	=	17.61	−	3.78
(25A)	Si	− 17069	=	120	×	(− 5.08)	×	28	13.83	=	18.91	−	5.08
(25B)	Si	22512	=	120	×	6.7	×	28	13.83	=	7.13	+	6.7
(26)	Sn	− 28603	=	120	×	(− 2.02)	×	118	16.02	=	18.04	−	2.02
(26A)	Sn	0	=	120	×	0	×	118	16.02	=	16.02	+	0
(27)	Ta	− 88759	=	120	×	(− 4.064)	×	182	18.106	=	22.17	−	4.064
(28)	Te	0	=	120	×	0	×	128	20.55	=	20.55	+	0
(29)	Ti	24480	=	120	×	4.25	×	48	13.69	=	9.44	+	4.25
(30)	Tl	− 18360	=	120	×	(− 0.75)	×	204	17.30	=	18.05	−	0.75
(31)	V	− 53305	=	120	×	(− 8.71)	×	51	9.05	=	17.76	−	8.71
(32)	W	− 60162	=	120	×	(− 2.77)	×	184	10.04	=	12.81	−	2.77
(33)	Zn	− 14900	=	120	×	(− 1.91)	×	65	9.85	=	11.76	−	1.91
(34)	Zr	32400	=	120	×	3.0	×	90	18.59	=	15.59	+	3.0
(35)	Ag	− 45080	=	120	×	(− 3.51)	×	107	9.78	=	13.29	−	3.51
(37)	Al	− 9720	=	120	×	(− 3.0)	×	27	9.05	=	12.05	−	3.0
(39)	I aq.	37720	=	120	×	2.48	×	127	30.23	=	27.75	+	2.48
(39A)	I	7010	=	120	×	0.46	×	127	33.23	=	32.77	+	0.46
(40)	Ba	81926	=	120	×	5.02	×	136	29.00	=	23.98	+	5.02
(40A)	Ba	72134	=	120	×	4.42	×	136	29.00	=	24.58	+	4.42
(40B)	Ba	54509	=	120	×	3.34	×	136	29.00	=	25.66	+	3.34
(41)	Cl	56786	=	120	×	13.33	×	35.5	28.41	=	15.08	+	13.33
(41A)	Cl	23010	=	120	×	5.4	×	35.5	28.41	=	23.01	+	5.4
(42)	K	33228	=	120	×	7.1	×	39	29.39	=	22.29	+	7.1
(42A)	K	53071	=	120	×	11.34	×	39	29.39	=	18.05	+	11.34
(42B)	K	37274	=	120	×	7.97	×	39	29.39	=	21.42	+	7.97

the outlet pipe in such a manner that it is split up into a large number of thin streams or films, each of which is forced to take a series of sharp sudden turns, during which the particles of water and impurities are left behind on the principle of inertia, because they are heavier than the gaseous stream, and cannot change their direction so quickly. The separated products, along with the condensed water, run down the gutters, collect at the bottom of the apparatus, and are blown out in the form of a brown mud through the front of the boiler by means of a pipe connection having a non-return valve. This principle is bound to find a very wide application, and its success depends on splitting the stream up into numerous thin layers so that the impurities occupy an appreciable space *compared with the total volume of the* steam being treated.

THE LAW OF HEAT OF FORMATION.

By Hawksworth Collins, B.A. (Camb.).

(*Continued from Last Week, Page 251.*)

Table III.

Heat of Formation of each Atom.		Theor.	Obs.	
(1) $As_2.O_3$ - 2(35100) + 32341 + 2(96155)	=	154451	154670	
(2) $Bi_2.O_3$ - 2(75200) + 3(96155)	=	138065	139200	
(3) Ca.O 53376 + 96155	=	149531	151900	
(3A) Ca.O 59568 + 71515	=	131083	131500	
(4) Cd.O - 31000 + 96155	=	65155	66300 63900	
(4A) $Cd.Cl_2$ 14252 + 23010 + 56786	=	94048	93700	
(4B) $Cd.I_2$ - 25308 + 2(36226)	=	47144	48830	
(5) $Co.F_2$ - 33842 + 2(76820)	=	119798	120300	
(6) $Cr_2.O_3$ - 2(9859) + 3(96155)	=	268747	267800	cryst.
(6A) $Cr_2.O_3$ - 2(9859) + 2(96155) + 71515	=	244107	243800	amorp.
(7) $Cu_2.Se$ - 2(19080) + 46380	=	8220	8000	
(8) Fe.S 0 + 19277	=	19277	18800	
(8A) $Fe_3.C$ 3(3629) - 2427	=	8460	8460	
(8B) $Fe.Si.O_3$ - 21101 - 12701 + 3(96155)	=	254663	254600	
(8B) $Fe_2.O_3$ - 2(21101) + 2(71515) + 96155	=	196983	197700 195000	
(8B) $Fe_3.O_4$ - 3(21101) + 2(96155 + 71515)	=	272037	270800	
(8C) $Fe_3.O_4$ - 3(31570) + 3(96155) + 71515	=	265270	265200	
(8D) $Fe_2.S_3.O_{12}$ - 2(69149) + 3(6217) + 6(32341) + 6(96155)	=	651329	650500	
(9) Hg.S 0 + 6217	=	6217	6210	
(9A) Hg.Br - 20890 + 45244	=	24354	24500	
(9B) $Hg.I_2$ -46590 + 2(36226)	=	25862	25640	
(9C) $Hg.Cl_2$ - 58600 + 2(56786)	=	54972	54490	
(9D) Hg.O - 76416 + 96155	=	19739	21500	
(10) $La.Cl_3$ 92000 + 3(56786)	=	262358	263000	
(11) $Mn.O_2$ - 1254 + 32341 + 96155	=	127242	126000	
(12) $Mo.O_2$ - 50900 + 2(96155)	=	141410	142800	
(13) $Na_3.As.O_4$ 3(32706) - 35100 + 32341 + 71515 + 2(96155)	=	359184	360800	

(13)	$Na_2.C.O_3$ 2(32706) − 13855 + 32341 + 2(96155)	=	276208	273700	
				278280	aq.
(13)	$Na.H.C.O_3$ 32706 − 15300 − 13855 + 32341 + 2(96155)	=	228202	227700	
(14)	$Ni.O.H_2O$ − 34590 + 96155 + 0	=	61565	60840	
(14A)	$Ni.O$ − 10040 + 71515	=	61475	61500	
(14B)	$Ni.S$ 0 + 19277	=	19277	19500	
(15)	$Ni.O_2.SO_2.7H'_2O$ − 8065 + 2(96155) + 0 − 7(3205)	=	*161810*	*162530*	
(16)	$Na_3.P.O_4$ 3(32706) − 8593 + 8(96155) + 71515	=	449505	452400	
(16A)	$Ba. H_4.P_2.O_4$ 81926 − 4(15300) + 2(0) + 4(96155)	=	405346	403000	
(17)	$K.H_2.P.O_4$ 37274 − 2(15300) + 8593 + 71515 + 3(96155)	=	375247	374400	
(17A)	$H_3.P.O_3$ − 15300 − 2(24350) + 0 + 3(96155)	=	224465	224630	liq.
(18)	$Pb.O$ 18500 + 32341	=	50841	50800	
(18A)	$Pb.Cl_2$ − 31394 + 2(56786)	=	82178	82770	
(18B)	$Pb.C.O_3$ − 40607 − 13855 + 32341 + 2(96155)	=	170189	170000	
(19)	$Pd.Cl_2.2KCl$ aq. − 75500 + 2(56786)	=	38072	39040	
(20)	$Ca.S.O_4$ 59568 + 0 + 2(32341 + 96155)	=	316560	317400	
(21)	$Fe_2.S_3.O_{12}$ − 2(69149) + 3(6217) + 6(32341) + 6(96155)	=	651329	650500	
(22)	$Sb_2.O_3$ − 2(48200) + 2(96155) + 71515	=	166343	166900	
(23)	$Cu_2.Se$ − 2(19080) + 46380	=	8220	8000	
(23A)	$Se_2.Cl_2$ − 10858 − 46987 + 23010 + 56786	=	21951	22150	
(24)	$Pb.Se$ 18500 − 1778	=	16722	17000	cryst.
				14300	*pp.*
(25)	$Si.O_2$ − 12701 + 2(96155)	=	179609	180000	
(25A)	$Ca.Si.O_3$ 59568 − 17069 + 3(96155)	=	330964	329350	
				344400	
(25B)	$Si.C$ 22512 − 21465	=	1047	1963	
(26)	$Sn.O$ − 28603 + 96155	=	67552	68090	
(26A)	$Sn.O$ 0 + 2(71515)	=	143030	141300	
(27)	$Ta_2.O_5$ − 2(88750) + 5(96155)	=	303275	301500	
(28)	aq.$Te.O_3$ 0 + 3(32341)	=	97023	98380	
(29)	$Ti.O_2$ 24480 + 2(96155)	=	216790	218400	cryst.
				215600	amorp.
(30)	$Tl_2.S.O_4$ − 2(18360) + 0 + 2(32341 + 96155)	=	220275	220980	
				221800	
(31)	$V_2.O_5$ − 2(53305) + 32341 + 4(96155)	=	310351	310500	
(32)	$W.O_2$ − 60162 + 2(96155)	=	132148	131400	
(33)	$Zn.F_2$ − 14900 + 2(76820)	=	138740	138220	
(33)	$Zn.O_2.H_2$ − 14900 + 32341 + 96155 − 2(15300)	=	82996	82680	
				83500	
(34)	$Zr.O_2$ 32400 + 2(71515)	=	175430	177500	
(35)	$Ag.N.O_3$ − 45080 − 23300 + 3(32341)	=	28643	28700	
(37)	$Al_2.Cl_6$ − 2(9720) + 6(56786)	=	321276	321960	
(39)	$Cu.I$ − 19080 + 36226	=	17146	16260	

ON THE EQUILIBRIUM DIAGRAM OF THE IRON-CARBON-NICKEL SYSTEM.

By Tsutom Kase.

Owing to the industrial importance many papers have been published regarding the nickel steels; but there is as yet no systematic study on the ternary alloys of iron-carbon-nickel system. The present investigation was undertaken to get the equilibrium diagram of the ternary system by means of thermal and magnetic analyses as well as microscopic and dilatometric methods and to shed further light on the ternary system. The results of the present investigation may be summarised as follows :—

(1) The equilibrium diagram of the iron-nickel system was newly studied with the result that iron and nickel form a continuous series of solid solution with a break. The A_3 transformation of iron is continuously lowered by the addition of nickel, showing temperature-lags on heating and cooling, in the case of irreversible nickel steels. A_3 and A_2 points coincide at about 5% Ni on cooling, and at about 10% Ni on heating. The A change has a transformation interval similar as the liquidus and solidus in the case of solidification. At room temperature, the heterogeneous range extends from ca. 15 to 30 per cent. of nickel.

(2) The equilibrium diagram of the nickel-carbon system is determined. Carbon and nickel dissolving carbon form a eutectic, of which the concentration of carbon is 2.22 per cent. and the temperature is 1318° C. The solubility of carbon in nickel is about 0.55% at the eutectic temperature, and about 0.25% at room temperature. Below the eutectic point the alloys undergo no change of structure.

(3) Nickel carbide is a dubious compound. The magnetic intentity of the solid solution consisting of nickel and carbon as well as its critical point decrease as the carbon increases.

(4) The equilibrium diagram of iron-carbon-nickel system is constructed. There exists no ternary eutectic, but a binary eutectic of a solid solution consisting of iron-nickel and carbon; its carbon content decreases with increasing nickel.

(5) The sum of the combined and dissolved carbons in the ternary alloys at room temperature rapidly decreases down to ca. 0.30% at 30% of nickel steel, and afterwards remains almost constant.

(6) The field representing the existence of cementite in the ternary alloys has been determined. It almost coincides with the range in which combined and dissolved carbon exists, that is, from 0 to about 30% of nickel.

(7) With the addition of nickel, the A_1 transformation of iron-carbon alloys is lowered and tends to be invisible at about 10% of nickel.

(8) As the nickel content increases, the carbon content at the eutectoid point decreases down to 0.30% at about 35% of nickel.

Japanese Journal of Physics.

General Notes.

MINERAL PRODUCTION OF CANADA, 1925.

The Dominion Bureau of Statistics has just issued its printed preliminary report on the Mineral Production of Canada during the calendar year 1925, which confirms the estimate issued at the beginning of the year to the effect that the 1925 production of minerals in Canada reached a total value of $224,846,237, an increase of $15,262,831 over the figures for the previous year and nearly as much as the record valuation of $227,859,665 attained in 1920, when the average range of metal prices was approximately 35% higher than it was last year.

Copies of the report, which contains data in regard to the output of each of the principal metallic and non-metallic minerals during the year, are obtainable on application to the Natural Resources and Industrial Information Bureau, The Canadian Building, Trafalgar Square, London, S.W.1.

CANADIAN FOREST FIRE LOSSES DURING 1925 SEASON.

Fire Hazard Increased in Intensity from Eastern Canada to Pacific Slope.

According to statistics gathered by the Forestry Branch of the Department of the Interior, the general forest fire situation in Canada, in 1925 was very similar to that of 1924, but with, in many cases, much heavier losses. With the exception of Ontario, the provinces east of the Lake of

the Woods experienced the lowest annual fire losses so far recorded; in the Prairie Provinces—Manitoba, Saskatchewan, and Alberta—the losses were moderate, while west of the Rockies in British Columbia, the destruction by forest fires was the greatest known.

In 1923 it will be recalled, the fire situation in Canada was exactly the reverse of 1924 and 1925, with heavy losses in the east and practical immunity from fire in the west. These extremes clearly indicate the dominant influence of varying weather conditions in respect to our annual regional loss from forest fires. Certainly the progressive increase of the fire hazard and loss from east to west in 1925 closely reflected the peculiar weather conditions. There were 5,490 forest fires in the Dominion last year, burning over an area of 1,913,066 acres, and causing a total loss of $6,646,889. During the period 1920-1924, the aggregate loss was $13,891,800.

EXPLOSIVE REACTIONS IN GASEOUS MEDIA.

A General Discussion on this subject is being organised by the Faraday Society to take place on Thursday, May 13, at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1. The proceedings will be divided into two sessions. The first, from 2.30 to 6.30, will deal with the subject generally, and Professor H. B. Dixon, F.R.S., will preside. An introductory survey will be given by Dr. W. E. Garner, and papers initiating discussion will be presented by Professor Dixon, Professor W. T. David, Dr. S .W. Saunders, Dr. R. V. Wheeler, Professor W .A. Bone and Dr. C. Campbell.

The second session, 7.45 to 10, will deal with Explosive Reactions Considered in Reference to Internal Combustion Engines. Sir Dugald Clerk, F.R.S., will preside and he will give an Introductory Survey, being followed by Professor David and Mr. H. T. Tizard. A dinner will be held between the sessions at the St .Ermin's Hotel. A full programme can be obtained on application to Mr. F. S. Spiers, 90, Great Russell Street, London, W.C.1.

THE FARADAY SOCIETY.

The Transactions of this Society, which have hitherto appeared three times a year, will in future be published bi-monthly in order to expedite the publication of papers presented to the Society. In addition to the six bi-monthly parts, reports of two General Discussions will be published annually, one in the spring and one in the autumn. The new arrangement begins with Volume XXII., 1926. The Publication Committee of the Society will be glad to consider papers on any branch of pure or applied physical chemistry, and under the new arrangement, rapid publication will be ensured. Communications should be addressed to the Secretary and Editor, 90, Great Russel Street, London, W.C.1.

PROCEEDINGS AND NOTICES OF SOCIETIES.

SOCIETY OF GLASS TECHNOLOGY.

A very full programme was carried through by Members of the Society of Glass Technology at their meeting in Stourbridge on March 17. During the morning two visits were paid. The first was to the Coalbournhill Glass Works of Messrs. Thomas Webb and Corbett, Ltd., where members were shown the methods of production of different kinds of table-ware, as well as different types of decoration, such as cutting, intaglio ,engraving and etching. In the showroom there were on view some magnificent speciment of English crystal glassware.

Members subsequently proceeded to the house of Mr. Phillip J. Pargeter, where they were privileged to see his fine collection of glassware, including two unique samples of the craftmanship. of the late Mr. John Northwood, namely, the reproduction of the famous Portland Vase, and a work of original design and execution, the Milton Vase.

At 1 p.m. the President, Mr. T. C. Moorshead, presided at luncheon in the Talbot Hotel, Stourbridge. A large and representative gathering of members welcomed, as guests, Mr. R. L. Mathews (Mayor of Stourbridge), and Mr. J. S. Williams-Thomas, and Mr. W. H. Stuart, the two oldest leaders of the Stourbridge glass industry.

ROYAL INSTITUTION OF GREAT BRITAIN.

(21, Albemarle Street, London, W.1.)

Thursdays, April 29, May 6, 13. "The Imperfect Crystallisation of Common Things." By Sir William Bragg, K.B.E., LL.D., F.R.S., M.R.I., Fullerian Prof. of Chemistry.

Friday, April 30, at 9 p.m. W. H. Eccles, D.Sc., F.R.S. "*Wireless in the Empire.*"

New Patents.

These particulars of New Patents of interest to Readers have been selected from *the Official Journal of Patents, and* are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

8,888.—Commercial Solvents Corporation.—Synthetic resins. April 1st.

8,920.—Deutsche Gold und Silber Scheideanstalt vorm Roessler.—Production of heterocyclical arsenic compounds. April 1st.

8,659.—Jarny, E. J. P. C. de.—Manufacture of condensation products from phenols and formaldehyde. March 30th.

8,503.—Robinson, H. W.—Removal of tar acids from ammonia liquor, etc. March 29th.

Specifications Published.

224,921.—Barbet, E. A.—Method for the production of dehydrated alcohol.

246,430.—Soc. Pour La Fabrication de la Soie Rhodiaseta.—Manufacture of solutions of cellulose derivatives.

247,507.—General Electric Co., Ltd.—Process for the manufacture of thin sheets of tungsten, tantalum, molybdenum and other refractory metals.

249,370.—Badische Anilin & Soda Fabrik.—Process for the manufacture and production of solid calcium nitrates.

249,402.—Johl, A.—Process for the production of barium hydroxide from barium sulphide.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25 ,Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

247,250.—Acridine derivatives; medicinal preparations. — Schnorf, C., 4, Bergstrasse Zurich, and Hefti, D., Alsetten, near Zurich, Switzerland.

Easily soluble derivatives of 9-amino-acridine, suitable for therapeutic use, are prepared by combining a 9-aminoacridine compound with a carbohydrate. The solutions of the compounds may be rendered isotonic by addition of glycerine, common salt, hydrochloric acid, etc. In examples a finely powdered mixture of 2-ethoxy-6 : 9-diamionacridine hydrovhloride and galactose is heated under a reflux in 90 per cent. alcohol on the water bath and the powder which separates is filtered, recrystalised from methyl alcohol and dried; 2-ethoxy-6 : 9-diaminoacridine hydrochloride is boiled with an aqueous solution of milk sugar, filtered and to the cold filtrate are added glycerine, normal hydrochloric acid and water to obtain a solution ready for use; the same acridine derivative is dissolved in a hot aqueous solution of galactose.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

RUSLAC.

465,592.—Chemical substances used as anti-corrosive, preservative and waterproof dressings for metals, wood, stone, cement and brickwook.—Anti-Corrosive Products Company, "Sunnydale," Crofton Road, Orpington, Kent. April 7th.

HERMOSOL.

465,557.—Chemical substances prepared for use in medicine and pharmacy.—H. J. Smith (Chemists) Ltd., 2, Stanley Road, Acton, London, W.3. April 7th.

TRYPOXYL.

466,935.—Chemical substances prepared for use in medicine and pharmacy.—Les Etablissements Poulenc Freres, 86 and 92, Rue Vieille-du-Temple, Paris, France. April 7th .

B459,965.—Device bearing words "FIRST DUTCH" for Natural Ironoxide, being an unmanufactured Ore produced in Holland, for use in purifying gas.—Naamlooze Vennootschap Algemeene Ijzererts Mattchappij, van Broeckhuysenstraat 29, Nijmegen, Gelderland, Netherlands. April 7th.

WANTED BACK NUMBERS OF THE *CHEMICAL NEWS.*

Two copies each of the following numbers wanted :—

Vol.	Year.	Number.
1	1859-60	3
2	1860	30
2	1860	45
5	1861	129, 134
6	1862	136, 144, 157
7	1863	161-173, 182
9	1864	214-219
11	1866	266, 268
12	1865	317
13	1866	318-324, 326-328
14	1866	355
15	1867	370-373, 378, 387.
16	1867	412
18	1868	472
19	1869	489
21	1870	528-532
25	1872	632
27	1873	684
29	1874	736, 737, 739, 740, 751
31	1875	788, 789
33	1876	841, 848, 849, 850.
64	1891	1650
73	1896	1886
75	1897	1936
80	1899	2084, 2087
89	1904	2306
116	1917	3013
117	1918	3035, 3051, 3053, 3054 3059, 3063
118	1919	3064, 3066 to 3070.

Three copies each of the following numbers of the *Chemical News* wanted :—

3013—Vol. CXVI., Year 1917.
3035, 3051, 3053, 3054, 3059 and 3063—Vol. CXVII., Year 1918.
3064, 3066 to 3070—Vol CXVIII., Year 1919.

Address, "Back Numbers," *Chemical News*, Merton House, Salisbury Square, London, E.C.4.

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eustatic rise of sea-level following on the melting of the great Permo-Carboniferous ice-sheets.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

The Oilfields of the Maracaibo Basin. By CAMPBELL M. HUNTER, O.B.E., M.A., A.M.Inst.C.E., F.R.G.S., F.G.S. (Member).

The Maracaibo Basin is a horse-shoe shaped area, bounded on the west, south and east by mountain ranges, which are offshoots of the main Andean system, and on the north by the Gulf of Venezuela or Maracaibo. Within this area are situated the State of Zulia and parts of the States of Mérida, Tachira and Trujillo. Geologically, the State of Falcon also falls within the Maracaibo Basin, though topographically it lies outside to the eastward, between the sea and the mountains which flank Lake Maracaibo on the east. Roughly, the area embraced by the Maracaibo Basin is about 25,000 square miles, or 33,000 square miles if the State of Falcon is included.

The climate and vegetation within this wide area varies considerably, ranging from barren semi-arid districts in the north to dense tropical vegetation in the south.

CONCLUSION.

The object sought in this paper has been to give a general presentation of the oil industry in the Maracaibo Basin as it stands to-day. Already so much development work has been accomplished on the major oilfields that highly informative monographs could be written of each. Similarly, the geology of the area has been so far elucidated that in several districts drilling can now be undertaken on a large scale with every assurance of success. Yet analysis of the successes achieved shows these as in every oilfield to have been the outcome of infinitely detailed geological study of the area in question.

Without the assistance and collaboration of the managers and local staffs of the various oil companies, notably those of the Lago Oil and Transport Company, the Royal Dutch-Shell interests, and the British Controlled Company, this paper could not have been written, and as such the author tenders to them his sincere thanks.

INSTITUTE OF METALS.

On the Equilibrium Diagram of the Aluminium-Zinc System. Recently submitted by PROFESSOR TOMIMATU ISIHARA. (From the Research Institute for Iron, Steel, and other Metals, Sendai, Japan.)

The equilibrium diagram of the aluminium-zinc system has been studied by many investigators. Among them, Heycock and Neville thoroughly studied the diagram by means of thermal analysis, and Shepherd modified the diagram by placing the eutectic horizontal of 380° C. between 2 and 50 per cent. of aluminium; he also added two more fields of homogeneous solid solution on the zinc and aluminium side. Rosenhain and Archbutt published, in 1912, the results of their valuable investigations on the same subject by means of thermal analysis and the study of microstructures; Bauer and Vogel suggested a modification of the diagram. Hanson and Gayler also studied this same system of alloys microscopically and determined its diagram. W. Sander and K. L. Meissner modified the solubility line of zinc in aluminium in Hanson and Gayler's diagram by using, in addition, the electric-resistance method, but their investigation was only limited to the aluminium-rich portion of the system. T. Tanabe published the results of his investigation on the same subject by means of thermal analysis, microstructure, and the electric-resistance method.

In all these diagrams the liquidus consists of three branches, with the exception of those of Heycock and Neville, and Shepherd; but the solidus and solubility line in solid phases show a great divergence from each other, most of the changes in solid phases having been investigated by the quenching method.

A Method of Improving the Properties of Aluminium Alloy Castings. Submitted by S. L. ARCHBUTT, F.I.C., Member (Teddington). (From the National Physical Laboratory.)

The present paper describes some experiments on methods of improving the properties of aluminium alloy castings. This work is part of the programme of research on light alloys being carried out at the National Physical Laboratory for the Engineering Research Board of the Department of Scientific and Industrial Research.

Aluminium alloys cast in sand are in general inferior in mechanical properties

and general soundness to corresponding castings made in metal or chill moulds. The slower rate of solidification which occurs in a sand-mould produces a coarse grain which is in itself detrimental to mechanical properties. These effects are, however, usually accentuated by general unsoundness, commonly of the type known as " pin-holing."

The " pin-holes " are small cavities more or less spherical in shape, fairly uniformly disseminated through the body of the casting.

Coarseness of grain and pin-holing are accentuated in sand-castings by high pouring temperatures. If melting and pouring temperatures are kept low, considerable improvement can be effected in respect of these defects.

Under the most carefully controlled conditions, however, employing normal foundry practice and treatment of melts, it has not been found possible at the Laboratory to effect more than a certain degree of improvement in soundness.

Using the 1 in. diam. bar as a standard form of casting, cold dry sand moulds, melting temperatures not exceeding 730° C., pouring temperature as low as 650° C., and ample risers and runners, the general order of density of cast bars of aluminium alloy " Y " (with the skin on) is 2.735, with an occasional value as high as 1.750. These values are to be compared with 2.780 for corresponding bars cast in metal moulds.

OBITUARY.

PROFESSOR W. J. LEWIS, F.R.S.,
(*Professor of Mineralogy at Cambridge.*)

The death took place on Friday, April 16, of Professor Lewis, at the age of 69 years.

A PROFESSOR'S ESTATE.

The late Professor Edward Granville Browne, F.R.C.S., Professor of Arabic in Cambridge University, who died on January 5, 1926, left estate of £166,167 (net personalty £162,811). He left £4,000 for Oriental studies at Cambridge.

FORTHCOMING EVENTS

ROYAL SOCIETY OF ARTS.

Monday, April 26, at 8 p.m. (Cantor Lecture.) Charles Reed Peers, C.B., M.A., Director S. A., Chief Inspector of Ancient Monuments, H.M. Office of Works, " Ornament in Britain." (Lecture II.)

Wednesday, April 28, at 8 p.m. (Ordinary Meeting.) James Paterson (of Messrs. Carter Paterson & Co., Ltd.), " Horse Traction and Motor Traction."

ROYAL MICROSCOPICAL SOCIETY.

20, Hanover Square, London, W.1.

The section of the Society which has been formed to deal with the " Industrial Applications of the Microscope," and to assist in the development of Scientific Research in British Industries, will hold its next meeting at 20, Hanover Square, W.1., on Wednesday, April 28, 1926, at 7 for 7.30 p.m. Dr. Harold Moore, O.B.E., D.Sc., Ph.D. (Director of Metallurgical Research, Royal Arsenal, Woolwich), will preside.

7.30 p.m.—Messrs. R. & J. Beck, Ltd., will exhibit the Swan Photomicrographic Apparatus for Workshop Use, and Radial Metallurgical Microscope.

Mr. Harold Wrighton, B.Met., F.R.M.S., will give a Demonstration of the Preparation of Metallic Micro-specimens.

8.0 p.m.—Mr. J. H. G. Monypenny will read a Communication: " Some Microstructural Features of Modern Rustless Steels."

THE INSTITUTE OF METALS.

ANNUAL AUTUMN MEETING IN BELGIUM.

It is now possible to give preliminary details of the Annual Autumn Meeting which, as previously announced, is to be held in Liége from September 1-4, thanks to the kind invitation of the Association des Ingénieurs Sortis de l'Ecole de Liége.

The Meeting will be the first to be held on the Continent since the very successful Ghent Meeting of 1913. It is hoped that it will attract a large number of Members both from Great Britain and other countries. Scientific and other papers, discussions, receptions, concerts, visits, etc., will make up a full and interesting four days' programme. Those intending to be present should communicate with the secretary, 36, Victoria Street, London, S.W., so as to facilitate the making of arrangements.

At the afternoon meeting, the President, Mr. T. G. Moorshead, presided. Three papers were presented, as follows :—

The Flashing of English Crystal by Cobalt Blue Glass. By PROF. W. E. S. TURNER AND F. WINKS, M.Sc.Tech.

In presenting this paper, Prof. Turner referred to the erroneous notion that successful flashing depended only upon the thermal expansion of the two glasses being nearly equal. The development of stress in glass depended also on (*a*) the rate at which the viscosity changed as the metal cooled down, and (*b*) the rate at which the glass lost its heat.

In the course of the investigation, two sets of glasses were made, the one soda-lime glasses, the other potash-lead oxide glasses. The amount of cobalt oxide added varied from 0 to about ½ per cent. In both series the effect of the cobalt oxide was to modify the thermal expansion only slightly, namely, about 3 or 4 per cent. Cracking in the flashing process was probably due to a difference in the rate at which the blue and coloured glass cooled off, or absorbed and lost heat. In experiments at the furnace it was found that the rate of setting increased (that is, the working range decreased) as the amount of cobalt oxide increased.

Some Notes on the Use of Sillimanite in Glass Works Practice. By A. COUSEN, M.Sc., AND PROF. W. E. S. TURNER.

This paper was presented by Prof. Turner, who stated that sillimanite showed up best under high temperature firing. Some of the uses to which sillimanite had been applied, with good results, in glass works practice, were :—

(a) For pot or potettes;
(b) For lining the sieges of furnaces;
(c) For gates for damming the flow of glass in the Danner Tube-Drawing Machine, and also in a flow-feeder type of machine, at the back of the forehearth of the furnace;
(d) For pot-rings;
(e) In the form of slip or paste in the stacks from regenerators in furnaces.

Some Remarks upon Recuperative Gas-Fired Furnace Practice. By PERCIVAL MARSON.

This paper was read for Mr. Marson by Mr. F. G. Clark. Attention was first of all directed to the importance of the provision of suitable hard-burnt and well shrunk refractory materials for the construction of the furnace chamber and its siege. The best and cheapest form of siege was one made up with ground potsherds admixed with the least proportion possible of plastic binding clay, tamped *in situ*, with a superficial 2-inch layer of sillimanite or andalusite material bonded with 8% of refractory ball-clay. The design of the glass pocket was another feature calling for the careful consideration of the purchaser. One very successful design of glass pocket has a ternary air inlet, which gives sufficient or partial combustion to the gas passing towards the main secondary air stage, thus keeping the pocket at a suitable temperature which enables the pocket to be emptied in a few minutes.

A self-contained furnace with a step grate producer has many points in its favour on account of its simplicity, low initial cost and maintenance cost as compared with a producer plant built away from the furnace. In addition, its efficiency was remarkably good, and although the externally built producer enabled the production of better gas, it entailed a considerable greater amount of labour and precaution in working when connected up with pot furnaces.

Pot failures could be classified as due to (1) The composition and nature of the pot clay mixtures, their manufacture and annealing; (2) Faulty methods of operating the furnace or bad furnace design; (3) The method of treating the pot and the design or shape of the pot itself.

Owing to lack of time, two other papers on the agenda were taken as read, namely : (a) *The Effect of Chlorides on the Melting and Working of Potash-Lead Oxid-Silica Glasses.* By EDITH M. FIRTH, B.Sc., F. W. HODKIN, B.Sc., CONSTANCE M. MUIRHEAD, B.Sc., M. PARKIN, M.Sc., AND PROF. W. E. S. TURNER.
(b) *The Production of Opalescence by Chlorides in Potash-Lead Oxide-Silica Glasses.* By EDITH M. FIRTH, B.Sc., F. W. HODKIN, B.Sc., CONSTANCE M. MUIRHEAD, B.Sc., AND PROF. W. E. S. TURNER.

GEOLOGICAL SOCIETY OF LONDON.

At the meeting held on March 24, at Burlington House, London, W.1.

Sir T. W. Edgeworth David, K.B.E., D.S.O., F.R.S., delivered an interesting lecture on Salient Features in the Stratigraphy, Tectonic Structure, and Physiography of the Commonwealth of Australia.

developed in Western, Central, and South Australia. The proterozoic rocks of Northern Australia are partly formed of thick dolomites, possibly a forerunner of the Great Barrier Reef of to-day. Basic lavas and tuffs, 3,000 feet thick, preceded a great ice-age in late Proterozoic or early Cambrian time. Marine Cambrian strata occur chiefly in Northern and Central Australia and South Australia, with patches in Victoria, Tasmania and Queensland. Ordovician rocks attained a thickness of 40,000 feet in Victoria and Central Australia. Igneous intrusions and unconformity separate the Ordovician rocks from the Silurian. In the Devonian rocks of Queensland, coralline limestone, 7,000 feet thick, is probably another ancestor of the Great Barrier Reef. In Carboniferous time a south-eastern shore of "the Tethys Sea" is well defined in the north-west of Western Australia. Carboniferous and Devonian time were periods of granitic intrusions and effusive rocks. In Permo-Carboniferous time half Australia was under ice. This was the chief coal-forming epoch, followed by more coal (in Triassic and in Jurassic times) developed in immense epicontinental lakes in Eastern and Central Australia, near which carnivorous Deinosaurs existed.

Marine Jurassic strata in Australia are only found in "the Tethys Sea" of Western Australia. The great dolerite-sills (comparable with the Karroo dolerites) of Tasmania possibly closed Jurassic time. Cretaceous time witnessed great peripheral and central marine transgressions. The Neocomian Sea was probably cold, and epeirogenic uplift in East Central Australia replaced marine by lacustrine conditions; this uplift was prabably accompanied by small local glaciation. In Western Australia the last of "the Tethys Sea" is represented by the Lower Santonian with *Uintacrinus* (comparable with the Arriloor Beds of Southern India). Cretaceous strata were slightly folded in Pre-Oligocene time Eocene marine deposits are mostly wanting except, perhaps, in New Guinea, but the Winton Series may be partly Eocene.

Oliogocene time was one of very extensive peneplanation, which was prolonged into the Miocene, and in places into early Pliocene time. A rock-crust, or "petroderm" ("Hartrinde" or Walther) formed over the more arid parts of this peneplain. Marine transgressions occurred all along the southern coast of Australia, mostly following on the eruptions of the "older basalts."

In Miocene time there were warm seas with large foraminifera (*Lepidocyclina*) and reef-forming corals, even in Tasmania. The earliest marsupials are found there in the Miocene beds. Miocene brown-coal deposits up to 800 feet thick, formed partly of *Fagus* and *Banksia*, occur in Victoria. "Deep leads' of gold and tin were formed inland. In New Guinea the oil-belt was developed during the Miocene Period.

In Pliocene time the whole peneplain underwent differential movement which was strongest in Eastern Australia. Alkaline lavas were erupted from tensional fault-planes in the old peneplain. Epierogenic uplift (during the "Kosciusko epoch" of E. C. Andrews) now followed, and became accelerated in a late Pliocene epoch. The Rift Valley of Australia formed mostly during this uplift. This later movement was accompanied by widespread eruptions of basalts with some andesites. The Great Barrier Reef was forming, and possibly commenced to develop even earlier.

The southern edge of the Lake Eyre peneplain became tilted northwards, and that of Western Australia eastwards, bringing about interior drainage and local aridity. The Pleistocene ice-age followed, together with a pluvial epoch, when Lake Eyre once more drained seawards. Crocodiles and gigantic marsupials were then abundant in Central Australia. The Tasmanian aborigines arrived iu Tasmania by way of the Malay Bridge, possibly during a eustatic negative movement of the sea. As the Ice Age ended, the sea-level rose, drowning the coastal valleys. The rainfall decreased. Lastly, the Australian aborigines arrived, perhaps bringing with them the Dingo. In the last few thousands of years the sea-level has fallen by about 15 feet.

The salient features in the tectonic structure are briefly discussed, with especial reference to Suess's views as to the arrangement of the Australian arcs, and the physiographic features are discussed chiefly with reference to the phenomena of arid erosion. The origin of the inland sand-hills of Central Australia is attributed to the disintegration of the widespread Permo-Carboniferous sandstones, for the later seas of that period transgressed over large areas of Australia, possibly in part through a

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A COMPACT AND COMPREHENSIVE SERIES OF REACTIONS AND TABLES IN CHEMISTRY.

By ROBERT SAXON, B.Sc., F.C.S.

(*Continued from Page* 203.)

Theoretically the HCl remains constant, and no oxygen is given off. This is not exactly true, but nearly so.

(iii) 2H) 2H : 2Cl. 2H. 2(OH (Mn(
$Mn(OH)_2$

Electrolysis is the safest way of getting hydroxides without the hindrance of other salts.

Concentrated hydrochloric acid asserts itself and attacks the anode. Wherever possible the chloride is formed, where not so the gas chlorine is dissolved by the liquid to saturation point, when it is given off freely. This forms a convenient means of getting and testing chlorine, without the unsatisfactory explanation of the hidden secondary reactions using sulphuric acid, a peroxide or per-salt, and a chloride. Here we have simply HCl and water :—

2H) 2H : 2(OH) : 2H : 2Cl (C(2Cl
—.—.—.—.—.—.—.—

Carbon is not attacked by chlorine. However, it seems possible that its superior negative charge, where water is not greatly in predominance, accepts the positive of the anode and starts the "exchange of partners" along the chain.

Concentrated hydrobromic acid will yield bromine rapidly, colouring the water, and concentrated hydriodic acid gives iodine. Chlorine, bromine, or iodine may be separated from the rest by heat. Chlorine being a heavy gas will fall into a gas jar and push out the air, bromine is a liquid, and iodine a solid at ordinary temperatures. Much better ways of preparing the gases electrolytically is to take the most concentrated solution possible of a chloride, bromide, or iodide. We may represent the reaction with the sodium salt thus :—

(i) 2H) 2H : 2(OH) : 2Na : 2Cl (C(2Cl
—.—.—.—.—.—.—.—

Here we have an ionic system in which four charge carriers, two positive, H and Na, and two negative OH and Cl, are ready to join bonds, either between any pair, or with three, or indeed, with all the four, where the temperature is suitable, form solids and drop out of the system.

(ii) 2H) 2H : 2(OH) : 2Na : 2Br (C(2Br
—.—.—.—.—.—.—.—

(iii) 2H) 2H : 2(OH) : 2Na : 2I (Cu(2I
—.—.—.—.—.—.—.—

We might imagine these four ions of hydrogen, hydroxyl sodium, and iodine to be in some sort of a ring so spaced from each other that they are equidistant from one another, and that there is as much opportunity for the hydrogen, say, to unite with the iodine, as with the hydroxyl or sodium. Given certain conditions, these compounds might be formed. At the ordinary temperature, however, the four simply mingle and move about one another, "challenging" such unions.

(iv) 2H) 2H. 2(OH) : Mg : 2Cl (C(2Cl

We now understand that we are dealing with a solution, and therefore do not indicate the fact. When confronted with such an arrangement, we take all the substances outside the two electrodes, that is the 2H and the 2Cl, and thus arrive at the new compound ionised, of course, namely $Mg(OH)_2$, in ionic notation Mg : 2(OH). As this is insoluble it does not remain ionised, and remembering that we *start with a solution* but do not indicate the fact, we do indicate the fact that we get an insoluble body by underlining it so thus :—

(v) 2H) 2H : 2(OH) : Mg : 2Cl (C(2Cl
————

There is no chance of confusion, for the symbols : say that we start with a solution, and solid magnesium hydroxide is written $Mg(OH)_2$, therefore the line indicates the

fact that magnesium hydroxide is formed, not taken.

(vi) 3H) 3H : 3(OH) : Al : 3Cl : 3H : 3Cl

(3Cl

Here we indicate the fact that we take a solution of aluminium chloride in a solution of hydrochloric acid, and precipitate aluminium hydroxide, dissolved hydrochloric acid being also formed from fresh partners. The acid is necessary to a clear solution, and does not waste away except when the water is getting scarce. The *delivered hydrogen* and *chlorine* are *not ionised*, but in a totally different state to those within the electrode signs, having lost their electric charges, and become gases trying to get away from the ions.

(vii) 3H) 3H : 3(OH) : Fe : 3Cl : 3H : 3Cl

(3Cl

This is similar to the last. We cannot put such a reaction in the form of an " equation " thus :—

$$FeCl_3/3HOH/3HCl = Fe(OH)_3/3HCl/3H/3Cl$$

for such would not take place, the hydrochloric acid dissolving the ferric hydroxide. In electrolysis, however, the hydroxide does actually float about in the electrolyte, showing that the components thereof are driven together by the disruption of the water on one hand, and the ferric chloride on the other, this latter being brought about by the activity of the newly " divorced " hydrogen of the hydrochloric acid.

Anodic Oxidation is used in a good many processes to oxidise the anode. By oxidation we sometimes mean raising the valency of an element such as turning ferrous chloride $FeCl_2$ into ferric chloride $FeCl_3$. Such is done by making the anode of the element or compound which is to be oxidised. This can be done with water with those metals showing a tendency to form the oxide and not the hydroxide. Here we have a few :—

i 2H) 2H : 2(OH) (2Ag(Ag_2O/HOH (silver anode)

ii 2H) 2H : 2(OH) (Hg(HgO/HOH (mercury anode)

iii 2H) 2H : 2(OH) (C(CO/HOH (carbon anode)

iv 4H) 4H : 4(OH) (Si($SiO_2/2HOH$ (silicon anode)

v 2H) 2H : 2(OH) (Sn(SnO/HOH (tin anode)

vi 2H) 2H : 2(OH) (Pb(PbO/HOH (lead anode)

vii 4H) 4H : 4(OH) (Pb($PbO_2/2HOH$ (lead anode)

With metals there is always a tendency to form the hydrate. This always happens with the alkali and third group metals. It is noteworthy that the 2nd, 4th, and 6th group metals give the oxide.

viii 6H) 6H : 6(OH) (Sb($Sb_2O_3/3HOH$ (antimony)

ix 6H) 6H : 6(OH) (Bi($Bi_2O_3/3HOH$ (bismuth)

The hydrates of these are also formed.

x 2H) 2H : (OH) (Mn($Mn(OH)_2$, also Ni, Fe, Co, Cu.

xi 3H) 3H : 3(OH) (Fe($Fe(OH)_3$,

xii 4H) 4H : 4(OH) (W($WO_2/2HOH$ (tungsten anode).

Anodic Solution and Salt Formation.

Metals insoluble in acids such as platinum or gold yield to the attraction of chlorine, bromine, or fluorine in cold electrolysed haloid solutions. Nascent ions show more activity than nascent elements. Given a solution of a chloride and a metal anode, electrolysis will furnish the chloride of the metal. Hydroxide, however, is thrown down. This may be shown as follows :—

i 2H) 2H : 2(OH) : 2K : 2Cl (Mg(

$MgCl_2$

i 2H) 2H : 2(OH) : Mg : 2Cl (Mg(

$MgCl_2$

iii 3H) 3H : 3(OH) : 3Na : 3Cl (Al($AlCl_3$

iv 3H) 3H : 3(OH) : Al : Cl_3 (Al($AlCl_3$

The electric current seems to undo chemical sequence, and therefore we are not justified in saying that potassium hydrate precipitates magnesium or aluminium hydroxide during electrolysis. If that is so the original chloride will be reformed and last definitely. On the other hand it is a fact that the amount of alkali hydroxide increases. As an example of electrolytic reversal of chemical sequence compare the two following chemical and electrolytic sequences :—

2KOH/2HCl - 2KCl/2HOH,

2H) 2H : 2(OH) : 2K : 2Cl (2Cl.

In the *former, hydrochloric acid is mixed* with caustic potash, and as the whole is dissolved in water we get the system 2K : 2(OH) : 2H : 2Cl, which on evaporation gives us solid KCl. In the second case evaporation gives us caustic potash KOH.

v 2H) 2H : 2(OH) : 2K : 2Cl (Sn($SnCl_2$
vi 2H : 2(OH) : 2Na : 2Cl (Pb($PbCl_2$

This is the *form* we *adopt where we concern* ourselves only with the anode. We assume that hydrogen is given off at the cathode.

vii 2H : 2(OH) : 2K : 2Cl (Mn($MnCl_2$
viii 2H : 2(OH) : 2Na : 2Cl (Fe($FeCl_2$
ix 3H : 3(OH) : 3K : 3Cl (Fe($FeCl_3$
x 2H : 2(OH) : 2Na : 2Cl (Co($CoCl_2$
xi 2H : 2(OH) : 2K : 2Cl (Ni($NiCl_2$
xii 2H : 2(OH) : 2Na : 2Cl (Cu($CuCl_2$
xiii 2H : 2(OH) : 2K : 2Cl (Ag(AgCl/Cl
xiv 4H : 4(OH) : 4Na : 4Cl (Pt($PtCl_4$

This in each case is the fundamental reaction. The hydroxide, oxide or basic salt is always possible.

xv 2H : 2(OH) : 2K : $2(NO_3)$ (Mg($Mg(NO_3)_2$

xvi 2H : 2(OH) : Mg : $2(NO_3)$ (Mg($Mg(NO_3)_2$

xvii 2H : 2(OH) : $Mg(NO_3)_2$: 2K : 2(OH) (Mg($Mg(OH)_2$

These reactions probably occur at the same time, reforming potassium nitrate. Note that in the last potassium takes the nitric anion from magnesium while this latter takes hydroxyl anion from hydrogen, a natural sequence. If the solution became saturated with potassium hydroxide, the metal would be deposited. It thus appears that the cathods wins when there is insufficient water to ionise all the potassium. We have the same results with zinc, cadmium, tin, manganese, iron, cobalt, nickel, copper, and thallium.

xviii 3H : 3(OH) : 3K : $3(NO_3)$ (Al($Al(NO_3)_3$

xix 3H : 3(OH) :Al : $3(NO_3)$ (Al($Al(NO_3)_3$

xx 3H : 3(OH) : Al : $3(NO_3)$:3K : 3(OH) (Al($Al(OH)_3$

Also chromium and iron. Such reactions occur with metals which are strong bases with a measure of certainty depending upon the amount of water present. If that be lacking there is a tendency especially with weak bases such as copper and silver to deposit the metal and form the corresponding acid thus :—

xxi Cu) Cu : 2Cl : 2H : 2(OH) (Cu($Cu(OH)_2$

xxii 2H : 2(OH) : Cu : 2Cl : 2H : 2(OH) (Cu($Cu(OH)_2$

The key to these reactions is the delivered element or compound. Where copper is deposited the acid always shows its presence to an indicator. At the same time hydrogen is still delivered. The anodic copper hydroxide is decomposed, for very little is found in the anodic campartment. Copper and hydrogen displace one another in electrolysis according to their "nascence."

xxiii 2H : 2(OH) : Na_2 : SO_4 (Mg($MgSO_4$

xxiv $2H : 2(OH) : Mg : SO_4$ (Mg($MgSO_4$

xxv $2H : 2(OH) : 2Na : 2(OH)$: (Mg($Mg(OH)_2$

If a diaphragm (porous pot) be used inside a transparent jar for the anodic solution of a metal giving coloured salts, the reactions are more manifest than with colourless ones.

Copper, nickel, iron, and chromium give in the anodic compartment with a *porous diaphragm* containing the *cathode*, the lower chloride, immediately the current is switched on. This chloride (the electrolyte is as before potassium chloride) may be tested by withdrawing samples by a narrow tube. We may represent the *anodic solution* thus :—

$2H : 2(OH) : 2Na : 2Cl$ (Fe($FeCl_2$

Ammonia gives a flocculent deep green precipitate, which oxidises to the reddish ferric hydroxide. Litmus blues ronnd about the anode almost imperceptibly, but there is no evidence of chlorine bleaching. Addition of water causes an immediate veil of green which increases rapidly. We therefore represent the next part :—

$2H : 2(OH) : Fe : 2Cl$ (Fe($FeCl_2$

The precipitation of the green hydroxide proceeds rapidly, and unless the surface be protected with rock oil, ferric oxide appears there, but nowhere else. In three hours the whole iron anode, 3/16 of an inch in diameter, is eaten up, and the lower stratum of the electrolyte is distinctly acid when the ferric hydroxide has been formed. *There is no gas given off at the anode with* saturated solutions, and no trace of iron salts in the porous pot. There is a great evolution of hydrogen there.

Magnesium, zinc, cadmium, give an immediate diaphanous descending veil closely clinging to the anode and spreading under the surface of the liquid of a whitish bluish cast, where purple litmus had been added. The presence of minute quantities of the chlorides of these metals in solution is not easy to detect.

Soluble sulphates act in a similar manner, and we might represent the formation of magnesium hydroxide thus :—

$2H : 2(OH) : 2Na : SO_4$ (Mg($MgSO_4$

$2H : 2(OH) : Mg : SO_4$ (Mg($MgSO_4$

$2H : 2(OH) : 2Na : 2(OH)$ (Mg($Mg(OH)_2$

These reactions are certainly influenced by the proportions of the reacting substances, and excess of water always determines the production of hydroxide, so that until there is a sufficiency of alkali bydroxide produced it will form the hydroxide alone as it does in the experiments given above. A series of experiments with varying water contents of electrolytes on salts giving coloured hydroxides such as copper, nickel and iron will demonstrate the fact that electrolysing water is a powerful reagent.

Cathodic Reduction.

The hydrogen given off at the cathode may be instrumental in reducing it, as in the case of lead peroxide :—

HOH/PbO)PbO_2) $2H : 2(OH)$ (HOH/O

Here our cathode is shown in its conventional relative position, that is, to the left of the electrolyte, between the signs adopted for the cathode, namely,)). Proceeding outward to the left we see that the 2H of the water lops off one of the oxygen atoms of the lead peroxide to form water and lead oxide. At the same time the hydroxyl 2(OH) of the water surrenders its negative charge to the positively charged anode, represented by (, and passing outward, becomes water and oxygen. The anode sign is given single because we do not here concern ourselves with its nature.

We do not come across many cases of cathodic reduction, as compounds do not generally conduct electricity well. Lead peroxide is one of the few oxides which does so.

i HSH/Cu)Cu_2S) $2H : 2(OH) : 2Na : 2Cl$ (C(2Cl

ii HSH/2Cu)Cu_2S) $2H : 2(OH) : 2Na : 2Cl$ (Cu($CuCl_2$

iii HSH/2Cu)Cu_2S) $2H : 2(OH) : 2H : S : Cu : 2Cl$ (Cu($CuCl_2$

Thus may be formed the sulphides of cadmium, mercury, tin, lead, manganese, iron, and nickel.

Combustion.

We will leave electrolysis for ordinary chemical reactions. When substances burn

in air they combine with the oxygen to form an oxide. Solids do not unite with gases as such. Heat is necessary to change a little of them to the gaseous condition. As, however, heat is given out by combustion, some of this goes on vaporising the rest, and thus the reaction proceeds automatically. Here we give a series of reactions forming oxides, as comprehensive as possible :—

i $2H/O$ n/t HOH? *Meaning that 2 atoms join 1 atom, of hydrogen and oxygen respectively to form a molecule whose formula is probably* HOH. *Heat is required to start the reaction, but heat* (n big calories) *is given out thereby.* The formula of water is most probably more complex than HOH, perhaps 3HOH.

ii $2Na/O$ n/t Na_2O. Here a solid (Na) and a gas (O) unite to form a solid (Na_2O).

iii $2K/O$ n/wt K_2O. wt means " warm." Also Li, Rb, and Cs, also Tl.

iv Only liquids and gases will be indicated by underlining. $2NaH/2O$ n/t Na_2O/HOH or 2Na OH. Also LiH, KH, RbH, and CsH.

v Mg/O n/rt MgO. rt meaning " red heat." Also Be, Zn, Cd, and Hg. Ca, Sr, and Ba need wt.

vi $CaH_2/3O$ n/t CaO/HOH.

vii $2B/3O$ n/rt B_2O_3.

viii $2Al/3O$ n/it Al_2O_3. " it " meaning incandescent or white heat. Also Sc, Ga, Yt, In, La, Ce, Pr, Nd, Sm, Er, and Tl.

ix $B_2H_6/6O$ n/wt $B_2O_3/3HOH$.

x $B_4H_{10}/11O$ n/wt $2B_2O_3/5HOH$.

xi $B_6H_{12}/15O$ n/wt $3B_2O_3/6HOH$

xii $B_{10}H_{14}/22O$ n/wt $5B_2O_3/7HOH$

(This hydride is solid).

xiii $C//2O$ n/rt CO_2. This means crystallised carbon. Of course, amorphous carbon requires less heat. Also Si, Ti, Ge, Zr, Sn, Pb, and Th, " it " being required as we come down the list.

xiv $3C/2O$ /t C_3O_2/. Also Si.

xv C/O n/it CO. Great heat is required to form carbon monoxide, both elements being probably monad at the temperature. Also Si, Ti, Ge, Sn, and Pb.

xvi $3Ti/4O$ n/rt Ti_3O_4. Also Pb.

xvii $2Ti/3O$ n/rt Ti_2O_3. Also Zr and Pb, though extremely difficult to obtain pure by this method, hence we should write after such reaction, n.p. (not pure).

xviii $C_2H_2/5O$ n/t $2CO_2/HOH$.

xix $C_6H_6/15O$ n/t $6CO_2/6HOH$

xx $C_2H_6/7O$ n/t $2CO_2/3HOH$.

xxi $CH_4/4O$ n/t $CO_2/2HOH$.

xxii $Si_2H_2/5O$ n/t SiO_2/HOH.

xxiii $Si_2H_6/7O$ n/t $2SiO_2/3HOH$.

xxiv $SiH_4/4O$ n/t $SiO_2/2HOH$

Also GeH_4 ZrH_4, SnH_4 and ThH_4.

xxv $2LaH_3/6O$ n/t $La_2O_3/3HOH$. Also CeH_3, PrH_3 and NdH_3.

xxvi $2CeH_3/7O$ n/t $2CeO_2/3HOH$

xxvii $2P/3O$ n/t P_2O_3. Also As, V, Cb, Sb, Ta, and Bi.

xxviii $2P/5O$ n/t P_2O_5. Also V, As, Cb, Sb, Ta, and Bi.

xxix $2NH_3/3O$ n/t $3HOH/2N$.

xxx $2PH_3/8\,O$ n/t $3HOH/P_2O_5$. Also AsH_3 and SbH_3.

xxxi $S/2\,O$ n/t SO_2.

xxxii $Se/2\,O$ n/t SeO_2. Also Te.

xxxiii $S/3\,O$ n/rt -- SO_3.

xxxiv $Mo/3\,O$ n/rt MoO_3. Also W. (-- means "slowly.")

xxxv $3U/8\,O$ n/rt U_3O_8.

xxxvi $2Cr/3\,O$ n/rt Cr_2O_3. Also Mn, Fe.

xxxvii $3Co/4\,O$ n/rt Co_3O_4.

xxxviii Ni/O n/it NiO.

xxxix Cu/O n/rt CuO.

xl SH_2/O n/t HOH/S. Also SeH_2 and TeH_2.

xli $CuS/3\,O$ n/rt CuO/SO_2. Also Pb and Ni.

xlii $CuS/4\,O$ n/t $CuSO_4$. Also Mg, Zn, Cd, Ba.

xliii $SnS/4\,O$ n/t SnO_2/SO_2. Also Se.

xliv $B_2S_3/9\,O$ n/t $B_2O_3/3SO_2$. Also Sc_2S_3, Ga_2S_3, Y_2S_3, etc.

xlv $CS/4\,O$ n/t CO_2/SO_2. Also SiS, TiS, GeS, ZrS, SnS, oxides solid.

xlvi $P_2S_3/11\,O$ n/t $P_2O_5/3SO_2$

xlvii $P_2S_5/15\,O$ n/t $P_2O_5/5SO_2$. Also As, V, Cb, Ta and Sb.

xlviii $As_2S_2/7\,O$ n/t $As_2O_3/2SO_2$.

xlix $As_2S_3/9\,O$ n/t $As_2O_3/3SO_2$. Also Sb and Bi.

l $V_2S_4/13\,O$ n/rt $V_2O_5/4SO_2$. Also Ta.

li $Os/4\,O$ n/wt OsO_4 (warm).

lii $Cr_2S_3/9\,O$ n/rt $Cr_2O_3/3SO_2$. Also Fe, Mo, U.

liii $Cb_2OS_3/10\,O$ n/rt $Cb_2O_5/5SO_2$.

liv $2CrS/7\,O$ n/rt $Cr_2O_3/2SO_2$

lv $3MnS/10\,O$ n/rt $Mn_3O_4/3SO_2$.

lvi $Mn_3S_4/12\,O$ n/rt $Mn_3O_4/4SO_2$.

lvii $3MnS_2/16\,O$ n/rt $Mn_3O_4/6SO_2$. Also Fe and Co.

lviii $2FeS_2/11\,O$ n/rt $Fe_2O_3/4SO_2$.

lix $SeS_2/6\,O$ n/rt $SeO_2/2SO_2$. Also Te, Mo, W, and U.

lx $CS_2/6\,O$ n/t $CO_2/2SO_2$. Also Si, Ti, Ge, and Zr, but with solid oxides.

lxi $MoS_3/9\,O$ n/rt $MoO_3/3SO_2$. Also Te and W.

lxii BeO/K,Na,Mg,Al O/it. The O refers to the cals. evolved. As there is none, O/it means "no action at white heat."

lxiii BeO/H,Cl,Br,I,HCl,HBr,HOH O/rt. (None of these react at red heat.)

lxiv $BeO/2F$ n/t BeF_2/O.

lxv $2BeO/CCl_4$ n/t $2BeCl_2/CO_2$.

lxvi BeI_2/O n/t $BeO/2\,I$.

lxvii $4Mg/2CO_2$ n/t $3MgO/MgC/CO$.

lxviii $2MgC/CO_2$ n/rt $2MgO/2C$.

lxix $2Mg/CO$ n/rt MgO/MgC.

lxx Mg/CO n/it MgO/C.

lxxi MgO/C /2330d Mg/CO. Carbon monoxide seems to prefer high temperatures, at which both oxygen and carbon are probably monads.

lxxii ZnO/C n/1200d Zn/CO.

lxxiii $B_2O_3/6K$ n/rt $3K_2O/2B$.

lxiv $3NO/3B$ n/rt BN/B_2O_3.

. . .

lxxv $3B/Air$ n/t BN/B_2O_3.

lxxvi $3Al/Air$ n/mp AlN/Al_2O_3 (Heated to melting point.)

(This Series of Articles to be Continued.)

THE ANTAGONISTIC ACTION OF IONS IN THE NEUTRALIZATION OF SOLS.

By HARRY B. WEISER.

(From the Journal of Physical Chemistry.)

In the precipitation by electrolytes of sols stabilised by preferential adsorption of ions, it is usually considered that only anions count in the case of positive sols and only cations count in the case of negative sols. However, it was recognised by Freundlich a score of years ago that the critical precipitation concentration of electrolytes for sols may be influenced by the ion having the same charge as the sol; and a decade ago Bancroft pointed out that the amount of electrolyte required to precipitate any given suspension will vary with the nature of the cation, the anion and the disperse phase. This point of view does not seem to have been taken seriously by many people; but in 1920 attention was called to the fact that the influence of the ions having the same charge as the sol cannot be disregarded entirely in any case, and may be quite marked if the electrolyte precipitates only in high concentration. The precipitation value of electrolytes for sols was therefore defined as that concentration which results in sufficient adsorption of the precipitating ion to neutralisé the combined adsorption of the original stabilisinb ion and the stabilising ion added with the precipitating solution. There is thus an antagonistic action between the oppositely charged ions of a precipitating electrolyte in the sense that the greater the adsorption of the stabilising ion the greater must be the adsorption of the precipitating ion to effect neutralisation. Hence the precipitation value of an electrolyte with a strongly adsorbed stabilising ion is necessarily higher than that of an electrolyte with a weakly adsorbed stabilising ion.

Recognition of the importance of the stabilising ion in the precipitation of sols by electrolytes lead directly to a plausible explanation of the manner in which the precipitation value varies with the concentration of sol and furnished a partial explanation of the behaviour of certain mixtures of electrolytes with certain sols.

SUMMARY AND CONCLUSIONS.

1. The precipitation values for sols of mixtures of two electrolytes may be additive, may be greater than the additive values or may be less than the additive values.

2. The factors which determine the precipitation concentration of mixtures are: (1) the effect of each precipitating ion on the adsorption of the other; (2) the stabilising action of ions having the same charge as the sol; (3) the relatively greater adsorbability of ions at lower concentrations.

3. The antagonistic action between precipitating ions of the same charge is important in raising the critical concentrations above the addtive value, only in case the ions show a marked difference in adsorbability. This effect comes in when arsenious sulfide sol is precipitated by mixtures of salts of barium and potassium.

4. Although the stabilising action of ions having the same charge as the sol cannot be eliminated, the critical values for mixtures of two electrolytes may rise above the additive value even when the precipitating ions of the two are identical, thus eliminating antagonism between precipitating ions. (Sen.)

5. Variation from the additive relationship with mixtures of salt pairs having a common precipitating ion, results only when there is an appreciable difference in the adsorbability of the stabilising ions, the magnitude of the variation from an additive relationship being determined by this difference in adsorbability.

6. If the first and second factors referred to in (2) are not too pronounced, the precipitation values of mixtures may fall below the additive value on account of the relatively greater adsorbability of precipitating ions at low concentrations. An example of this phenomenon is the precipitation of arsenious sulfide sol by mixtures of the chlorides of potassium and cerium.

7. The influence of dilution of sol on the precipitation values of an electrolyte is de-

termined by the nature of the anion, the nature of the cation and the nature of the *sol*. The "*general dilution rule*" enunciated by Ghosh and Dhar fails to take all of these factors into account and so is necessarily limited in its applicability.

8. Strong adsorption of the stabilising ons of the precipitating electrolytes is not essential for the "acclimatisation" of sols in case there is strong adsorption of the precipitating ions during fractional agglomeration; on the other hand, strong adsorption of the stabilising ion is essential in case the successive *dilutions of the sol by fractional* precipitation is the determiuing factor. In either case acclimatisation to a greater or lesser degree is a necessary concomitant of fractional precipitation.

General Notes.

BRITISH STANDARD COPPER CONDUCTORS.

The British Engineering Standards Association has recently issued a revised edition of the British Engineering Standards Association ublication No. 7-1926, British standard specification for insulated annealed copper conductors for electric power and light. Few changes were found necessary in this revision, as is to be expected in a work of this character, although those made are of importance. One extra standard size (0.85 sq. ins.) has been added to the list of stranded cables. Tables have been included to cover the thicknesses of vulcanised bitumen insulated and sheathed cables. A full list of definitions relating to conductors and cables has also been included.

BRITISH IRON AND STEEL OUTPUT.

Production of pig iron in the United Kingdom during March amounted to 568,500 tons, as compared with 502,000 tons in February and 607,900 tons in the corresponding month of last year. The output of steel ingots and castings totalled 784,100 tons, the largest quantity for over a year, and comparing with 703,800 tons in the previous month and 684,700 tons in March, 1925.

EXHIBITION OF THE CZECHO-SLOVAK CHEMICAL SOCIETY.

May 14 to May 10, Inclusive.

The Exhibition, organised by the Chechosolvak Chemical Society, Prague II, Trojanova 13, will be held in the laboratories of the Chemical Institute of the Czech Technical High School, Prague II, Trojonova 13. Exhibits will include all chemical and laboratory apparatus, including furniture and equipment. A catalogue will be published giving the names of all exhibitors and details of their exhibits. For a small charge, exhibitors will be allowed to insert further details of their exhibits.

Conditions and Space.—Exhibits may be shown on :—

(1) Tables, one square meter costing 100-500 Kc.

(2) On floor, one square metre costiug 50-200 Kc.

(3) On walls, one square metre costing 50-100 Kc.

Applications for space must be accompanied for a fee of 100 Kc. and 30 Kc. on account of every square metre of space required. All applications are binding if accompanied by fees.

Application has been made for a Government grant of 5,000 Kc.

BOARD OF TRADE ANNOUNCEMENT.

Dyestuffs (Import Regulation) Act, 1920.

Applications for Licences in March, 1926.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during March, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 592, of which 515 were from merchants or importers. To these should be added 20 cases outstanding on the 27th February, making a total for the month of 612. Of the total of 612 applications received, 557, or 91 per cent., were dealt with with 7 days of receipt.

CANADIAN CEMENT INDUSTRY.

The Canadian mill output of cement during 1925 was 7,869,946 barrels, an increase of 101,294 barrels over the 1924 total. Shipments for the year showed an appreciable advance and totalled 8,116,597 barrels, valued at $14,046,704. Cement is produced in Quebec, Manitoba, Alberta and British Columbia. There was formerly a production of puzzolan cement from blast furnace slag in Nova Scotia, but this has been discontinued in recent years. In 1925, Ontario was the leading producer, sales in that province amounting to 3,462,359 barrels.

By provinces, the average selling price per barrel, f.o.b. plant, was as follows :—Quebec, $1.69; Ontario, $1.52; Manitoba, $2.25; Alberta, $2.31; and British Columbia, $2.37. Importations for 1925 amounted to 21,849 barrels, averaging $2.89 per barrel. Exports of Portland cement totalled 997,915 barrels, invoiced at $1,498,495.

CANADIAN OFFICIAL MINING NOTES.

The Scientific and Industrial Research Council of Alberta has just published a geological map of the Province of Alberta, by Dr. John A. Allan, one inch to 25 miles. Copies of the map may be obtained on application either to the Research Council at Edmonton, Alberta, Canada, or to the Natural Resources and Industrial Information Bureau, The Canadian Building, Trafalgar Square, London, S.W.1.

The Geological Survey Branch of the Dominion Department of Mines has just issued its Summary Report for 1924, Part B, which contains a report by Dr. G. S. Hume on the " Oil and Gas Prospects of the Wainwright Vermillion Area of Alberta." Copies of the report may be obtained on application to the Natural Resources and Industrial Information Bureau, The Canadian Building, Trafalgar Square, S.W.1.

ON FUNGI WHICH GROWS ON COAL.

Takho Iwasaki contributes an interesting paper on the above subject in the Technology Reports of the Tôhoku Imperial University. He describes experiments with the culture of fungi on divers kinds of coal, arriving ultimately at the following conclusions :—

(1) It is a strange fact that some fungi can grow on coal as I have discovered.

(2) From the fungi which grow on coal, I have distinguished the following three kinds as the results of pure culture :—

Aspergillus minimum, Wehmer.
Aspergillus Oryzae, Cohn.
Citromyces Pfefferianus, Wehmer.

(3) When fungi are inoculated on both coal powder and coal blocks, they can grow on them both except in special cases.

(4) The more advanced in coalification the coal is, the more unfavourable it is for the growth of fungi. On the brown lignite, they can grow most easily, but on the black lignite relatively they grow with difficulty, and perhaps never grow at all on the true coal.

(5) In the two different parts of coal, the fungi are richer in growth on the dull coal than on the bright.

(6) Among the three fungi, Aspergillus minimus is most favourable, Citromyces Pfefferianus comes next, and Aspergillus Oryzae is most unsuitable for growth on coal.

(7) For a thick growth of fungi, the coal is deficient in mineral matter.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

At the meeting on Thursday, February 11, 1926, the following papers were read :—

The Life-Cycle of the Nodule Organism " Bacillus Radicicola " (Beij.) in Soil, and its Relation to the Infection of the Host Plant. By H. G. Thornton and N. Gangulee. Communicated by Sir John Russell, F.R.S.

By means of a modification of Winogradsky's staining technique the changes in morphology of *Bacillus radicicola* in soil were followed. A regular cycle of changes was found, unbanded rods, cocci, and banded rods successively predominating in the soil. Increase in the percentage of cocci was associated with increased bacterial numbers and with the appearance of motile forms.

By modifying the liquid used to suspend the inoculum added to the soil, the time of appearance of cocci in predominance could be altered. In particular, inoculation of the soil with a bacterial suspension in milk + 0.1 per cent. $CaH_4(PO_4)_2 2H_2O$ hastened

the predominance cocci and increased the percentage to which they attained.

When the centre of a Petri dish of soil and sand is inoculated with a suspension of the bacteria, the latter commence, after a lag period, to spread radially at an approximate rate of 1 inch in 24 hours. The length of this lag is apparently related to the time taken for cocci to predominate in the soil, and is similarly affected by the nature of the inoculating fluid.

The bacteria multiply rapidly in the soil into which they have recently spread, so that the nature of the inoculating fluid also exerts a remote influence on bacterial numbers. Thus, inoculating of the soil with a bacterial suspension in milk containing 0.1 per cent. $CaH_4(PO_4)_2 2H_2O$ results in a greater spreading of the bacteria through the soil and in greater multiplication as a distance from the point of inoculation than is the case when soil is inoculated with a suspension in milk alone.

Lucerne plants grown from seed inoculated with a suspension of bacteria in milk + 0.1 per cent. $CaH_4(PO_4)_2 2H_2O$ showed a considerable increase in nodule numbers and in yield compared with plants from seed inoculated with a suspension in milk alone.

The Meiotic Phase in Certain Mammals. By C. E. WALKER. Communicated by Sir John Farmer, F.R.S.

Stages in the telophase of the somatic mitoses resemble some of the stages in tbe prophase of the first meiotic division very closely.

The daughter chromosomes of the last somatic division before the first meiotic split longitudinally. As the splitting proceeds, so the semivalent half-chromosomes lengthen out and become thinner, until the whole necleus is filled with fine semivalent threads. This is the end of the telophase. These semivalent threads join together again in pairs to form univalent filaments. The univalent filements then join laterally in pairs to form bivalent loops. The filaments, after forming these loops, separate except at their ends, which remain pointed. These are the meiotic bivalent chromosomes. When the first meiotic division takes place, the paids of whole somatic chromosomes, joined by their ends, separate and are distributed, half to each daughter cell. The longitudinal split in the daughter chromosomes of the somatic division which reappears in the telophase of the first meiotic division, is not consummated until the second meiotic division.

The term " exeilesis " is suggested for the process by which each of the daughter chromosomes becomes converted into two semivalent threads.

Papers read in title only :—

Further Micro-Injection Studies on the Oxidation-Reduction Potential of the Cell Interior. By J. NEEDHAM AND DOROTHY NEEDHAM. Communicated by Sir Frederick Hopkins, F.R.S.

The micro-injection of *p*H and *r*H indicators into living cells has led to the following conclusions :—

1. The *r*H indicators exhibit no anomalies when injected into *Amœba proteus.* It appears, therefore, that all the dyes on the scale may be used with biological material.

2. The amœba is capable of oxidising the lencoform of indicators whose *r*H is lower than its own.

3. The *r*H of the amœba is probably independent of the percentage of oxygen in the external atmosphere.

4. *Nyctotherus cordiformis* (an anaerobic protozoon) possesses an internal *p*H of 7.1 and an internal *r*H of 19.0-20.0 under aerobic conditions.

5. *Nyctatherus cordiformis* possesses an internal *p*H of 7.1 and an internal *r*H of 9.5-10.5 under anaerobic conditions.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The Rugby Station of the British Post Office. By E. H. SHAUGHNESSY, O.B.E., Member.

SUMMARY.

This paper gives a general description of the Post Office high-power radio station erected at Hillmorton near Rugby. Tbe introduction sets out the requirements which the design had to meet.

The paper is divided broadly into three sections :—Power Plant, High-Frequency Generating Valve Plant, and Masts and Aerials.

The first section deals with the seleetion and type of power plant employed for converting the e.h.t. alternating-current supply to suitable e.h.t. direct-current and l.t. direct-current and l.t. alternating-current supplies for use on the various parts of the installation, and the precautions necessary in dealing with a wireless load of the magnitude involved. The method of providing

lighting for the masts for warning aircraft of obstruction is given.

The high-frequency generating-valve plant Section deals with the design of valve generating plant suitable for full-power transmission or subdivision into two transmitters for use with larger and smaller portions of the whole aerial, and gives the methods adopted for maintaining constant frequency, successive amplication and freedom from harmonics. This section includes —The e.h.t direct-current supply; the general scheme of circuits; the filament supply; the excitation unit; consideration in regard to the sizs of power unit; the power unit; the paralleling of valves in a power unit; the paralleling of power units; safety devices and control circuit; the control table; types of coupled circuits; the design of inductances for high power; relative positions of amplifiers and aerial circuit ;method of keying and shape of signal.

The masts and aerial section includes—A brief general description of the 820-ft. masts; the method of insulating the masts and the stays; the method of staying the masts; tensions on the stays, etc; the method of applying test load to top of masts; the aerial system; aerial insulation; aerial spreaders; earth system; curves of aerial resistance; voltage of aerial, etc.

The final section gives the general results obtained to date, and a brief description of the experimental telephony installation.

Introduction.

When the Government decided upon the provision in England of a wireless station with a world-wide range, the Post Office Engineering Department was entrusted with the task of its erection. The Wireless Telegraph Commission which was originally appointed under the chairmanship of the late Lord Milner, with Dr. W. H. Eccles (vice-chairman), Mr. E. H. Shaughnessy and Mr. L. B. Turner as members, undertook the general design of the station. The Post Office engineers in consultation with the Wireless Telegraph Commission carried out considerable preliminary experimental work and prepared detailed drawings and designs for the station equipment as a who'e and for most of the plant; they also prepared the detailed specifications to which manufacturers have designed or made the remainder of the plant.

In the preliminary design of the station it was considered that in order to ensure reliable communication when working on a wave-length of about 18,000m (16.66 kilocycles) a minimum working current of 500 amperes in an efficient aerial supported on 820-ft. masts would be required. To meet this requirement and provide a safe working margin it was decided that the high-frequency generating valve plant should be capable of dealing with an input of 1,000 kW to provide for a possible necessary low working efficiency of 50 per cent. Such an installation would produce a aerial current of about 700 amperes to meet bad atmospheric conditions.

Originally it was considered that sixteen 820-ft. masts would be required to support a suitable aerial but to avoid any unnecessary expenditure it was decided to erect in the first instance an aerial having a designed capacity of 0.045 μF on 12 insulated 820-ft. masts and to carry out tests to ascertain the limitations imposed on the aerial power obtainable by such factors as corona, insulation, etc., and to obtain data as regards the range of the station using this maximum power.

Site.

Owing to the large area required, considerable difficulty was experienced in obtaining a site, but ultimately an area of 900 acres (about 1 miles long by 1 mile wide) bounded on the east side by Watling Street and on the west side by the Oxford canal was obtained at Hillmorton about 4 miles south-east of Rugby. The ground is level and not surrounded by hilly or wooded country, although a fox covert on the site had to be demolished, as it was under the proposed aerial. A water supply is available from a stream running through the site, the nearby railways and the Oxford canal afford transport facilities. The station buildings are erected about the middle of the site.

Power Plant.

The question of the power supply for the station was one which was very carefully considered, and after a close examination of conditions on the basis of comparative costs and reliability it was decided to accept a bulk supply from the Leicestershire and Warwickshire Electric Power Co., who are the authorised suppliers in the area.

Conclusion.

As liaison member between the Wireless Telegraphy Commission and the Post Office the author would like to remark on the cordial collaboration which existed between the Commission and his engineers throughout the progress of the work, and in conclusion he desires to acknowledge the valuable help received in writing this paper from the Post Office Engineers directly responsible for the various sections of the work, namely, Mr. A. J. Gill on the power plant, Mr. R. V. Hansford on the wireless plant, and Col. A. S. Angwin and Mr. T. Walmsley on the masts, aerials and external plant.

TEMPERATURE CORRECTIONS TO READINGS OF BAUME HYDROMETERS, BUREAU OF STANDARDS BAUME SCALE FOR SUGAR SOLUTIONS (STANDARD AT 20° C.).

(Circular No. 295, U.S.A. Bureau of Standards. Prepared by C. F. Snyder.)

The Baumé scale is widely used in the sugar industry, particularly in connection with the sale of molasses and syrups, in preference to a true density determination. It seems to be the general practice to specify in the sales contract the Baumé of the molasses or syrup. In some instances the particular Baumé scale and the temperature are not specified in the contract. It is obvious that these should be stated. There have been a large number of different Baumé scales proposed and used since the original scale was devised by Antoine Baumé, a French chemist, in 1786. Prof. C. F. Chandler, in a paper read before the National Academy of Sciences at Philadelphia in 1881, gave an admirable review of the origin and history of the Baumé scales in use up to that time. This subject of Baumé scales has also been discussed in B.S. Circular No. 59.

In the determination of the Baumé of a very thick molasses by spindle it is obviously necessary to make the determination at a higher temperature than 20° C. Various temperatures between 38 and 60° C. are used. In some cases theh spindle reading is corrected to the standard temperature, while in other cases no correction is applied. This condition has led to inaccuracies and misunderstandings.

In a number of instances in which the Bureau of Standards has acted as referee in disputes between the buyer and the seller of molasses the two contracting parties have accepted the Bureau of Standards Baumé scale for sugar solutions, proposed by Bates and Bearce. This scale, which is standard at 20° C., is based on the specific gravity values of Plato and on the modulus 145.

The table of Bates and Bearce lies between the "old" or "Holland" table and the "new" or "Gerlach" table, being in close agreement with the former up to about 13° and from that point on from 0.1 to 0.2° higher. A comparison of the differences in the three scales in the neighbourhood of 42 Baumé is given in Table 1.

Table 1.—Corresponding Degrees Baume.

Bureau of Standards scale modulus 145	"Old" or "Holland" scale modulus 144	"New" or "Gerlach" scale modulus 146.78
40.00	39.9	40.6
41.00	40.8	41.6
42.00	41.8	42.6
43.00	42.8	43.6
44.00	43.8	44.6

It is recognised that a density determination by means of a spindle on a viscous liquid of the character of molasses is not capable of yielding results of high precision. However, the method has become so firmly fixed in trade practice that it does not seem feasible to discard it in favour of one of the more precise picnometer methods.

It has frequently been necessary for purposes of comparison in trade transactions to make determinations of the Baumé of molasses by spindle at various temperatures and correct the readings to the standard temperature of 20° C. Since no table of temperature corrections for Baumé hydrometers has heretofore been available, it has been necessary to make the corrections as follows: The Baumé reading was converted to the equivalent in Brix; this Brix value was then corrected for temperature and finally converted back to the equivalent in Baumé. To eliminate this laborious method of correcting for temperature, Table 2 has been calculated. It is based on the values of the thermal expansion of sugar solutions of Plato, assuming the instrument to be of ena 16^{III} glass. The table is submitted as supplementary to the Baumé table of Bates and Bearce (Table 31, B. S. Circular No. 44) and the table of temperature corrections

for Brix hydrometers (Table 11, B. S. Circular No. 44).

The calculations were checked by Miss E. E. Hill of the volumetric laboratory of this bureau.

FORTHCOMING EVENTS

ROYAL SOCIETY.

May 6, at 4 p.m. Election of Fellows.

May 6. The Bakerian Lecture will be delivered by Prof. A. S. Eddington, on "Diffuse Matter in Inter-Stellar Space."

ROYAL INSTITUTION.

On May 6 and 13, Sir William Bragg will deliver two lectures on "The Imperfect Crystallisation of Common Things"; on May 20 and 27, Mr. U. R. Evans will deliver two lectures on "Corrosion, Tarnishing and Tinting of Metals," and on June 3 and 10 Dr. J. Newton Friend will deliver two lectures on (I) "Iron in Antiquity" (II) "Science in Antiquity." On Saturdays, at three o'clock, Dr. W. T. Calman will give two lectures on "The Shipworm," beginning on April 17; to be followed by two by Dr. Percy C. Buck on "The Song Form in England," with musical illustrations, May 1 and May 8; two by Dr. G. C. Simpson on "Atmospheric Electricity," May 5 and May 22; and one by Professeur Alexandre Moret on "Une Revolution sociale en Egypt vers 2,000 Av. J.C. (in French), May 29. The Friday Evening Discourses will be resumed on April 16, when Dr. A .W. Hill will deliver a discourse on "The Quest for Economic Plants." Succeeding discourses will probably be given by Prof. R. Whiddington, Dr. W. H. Eccles, Sir Frederick Kenyon, Mr. Seton Gordon, Sir Almroth Wright, Prof. J. Garstang, Prof. J. C. M'Lennan, of Toronto, and other gentlemen.

ROYAL SOCIETY OF ARTS.

John Street, Adelphi, London, W.C.2.

Monday, May 3, at 8 p.m. (Cantor Lecture). Charles Reed Peers, C.B.E., M.A., Director S.A., Chief Inspector of Ancient Monuments, H.M. Office of Works, "Ornament in Britain." (Lecture III.)

Tuesday, May 4, at 4.30 p.m. (Dominions and Colonies Section.) Charles Ponsonby, Managing Director, British Central Africa Company, "Nyasaland." Brig.-General Sir S. H. Wilson, K.C.M.G., K.B.E., C.B., Permanent Under-Secretary of State for the Colonies, will preside.

Wednesday, May 5, at 8 p.m. (Ordinary Meeting.) C. F. Elwell, B.A., "Radio—Its Past, Present and Future." Professor William Henry Eccles, D.Sc., F.R.S., will preside.

Thursday, May 6, at 4.30 p.m. (Special Meeting.) Sir Frank Baines, C.V.O., C.B.E., "Preservation of Ancient Cottages." Sir Charles C. Wakefield, Bt., C.B.E., LL.D., will preside.

Friday, May 7, at 4.30 p.m. The Rt. Hon. Lord Hardinge of Penshurst, will preside. (Indian Meeting.) Herbert Baker, A.R.A., F.R.I.B.A., "The New Delhi."

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

The next Meeting of the Society will be held on Wednesday, May 5, at the Chemical Society's Rooms, Burlington House, Piccadilly, W.1., at 8 p.m. The following papers will be read:—

"The Detection and Determination of Glycerin in Tobacco." By A. Chaston Chapman ,F.R.S., F.I.C.

"Further Notes on the Crystalline Bromides of Linseed and other Oils." By Harold Toms, M.Sc. (Work done under the Analytical Investigation Scheme.)

"The Polarimetric Determination of Sucrose in Condensed Milk." By A. Bakke and P. Henegger. (Summarised by E. B. Hughes, M.Sc., F.I.C.).

"The Determination of Very Small Quantities of Iron." By Henry L. Smith, B.Sc., F.I.C., and J. H. Cooke, B.A., A.I.C.

"The Separation of Iridium from Iron." By W. R. Schoeller, Ph.D.

"The Determination of Total Alkaloids, Sugar and Oily Substances in Opium." By Jitendra Nath Rakshit.

THE INSTITUTE OF PHYSICS.

"Physics in Industry."—The tenth lectnre of this series being given under the auspices of the Institute of Physics will be delivered by Mr. H. E. Wimperis, Director of Scientific Research, Air Ministry, and it will deal with "The Relationship of Physics to Aeronautical Research." The lecture, which will be open to the public, will be given in the Physics Theatre, Royal Col-

lege of Science, Imperial Institute Road, South Kensington, S.W.7., on Tuesday, May 11, at 5.30 p.m., and the Chair will be taken by Sir William Bragg, President of the Institute.

THE INSTITUTE OF METALS.

The sixteenth annual May lecture of the Institute of Metals will be delivered by Professor H. C. H. Carpenter, F.R.S., on "Single Metallic Crystals and Their Properties," at a General Meeting of the Institute, to be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, London, S.W.1., on Wednesday, May 19, 1926, at 8 p.m.

Non-members of the Institute desirous of attending the May lecture should apply to the Secretary, Mr. G. Shaw Scott, M.Sc., 36, Victoria Street, London, S.W.1.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, W.C.2.

Wireless Section Meeting.—Wednesday, May 5, at 6 p.m. (Light refreshments at 5.30 p.m.) "*On the Cause and Elimination of Night Errors in Radio Direction Finding.*" By Dr. R. L. Smith-Rose, M.Sc., and R. H. Barfield, M.Sc.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

9,203.—American Smelting & Refining Co.—Recovery of zinc as sulphate from dross. April 7th.

9,204.—American Smelting & Refining Co.—Recovering metals. April 7th.

9,529.—Lacell, H. G.—Production of chlorides from metallic oxides, etc. April 10th.

9,536.—New Jersey Zinc Co.—Treatment of zinciferous materials. April 10th.

9,172.—Soc. Anon. des Fours à Coke Semet-Solvay et Piette.—Production of ammonium sulphate. April 7th.

Specifications Published.

241,547.—Metropolitan Vickers Electrical Co., Ltd.—Devices for the chemica treatment of gases.

247,523.—Farbenfabriken vorm. F. Bayei & Co.—Process for the manufacture of alkali hydrosulphites.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25, Southampton Buildings, London W.C.2., at the uniform price of 1s. each.

Abstract Published.

247,471.—Desulphurising iron ores.—Millar W. S., 183, Fox Lane, Palmers Green, London.

Iron oxide; sulphur.—The process for desulphurisating iron ores by means of sulphur dioxide described in the parent Specification is carried out by the use of gases containing at least 50 per cent. of sulphur dioxide. Burner gases enriched with sulphur dioxide or the pure gas itself may be used. The iron remains in the furnace as a porous highly magnetic oxide and sulphur is condensed from the issuing gases. The introduction of steam facilitates the process.

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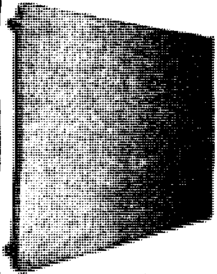

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VOL. CXXXII. No. 3447.
MERTON HOUSE, SALISBURY SQUARE, LONDON, E.C.4.
TELEPHONES :
Administrative : Central 6521.
Printing Works : Hop 2404.

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THE DETECTION AND ROUGH ESTIMATION OF NITRATES.

By L. J. CURTMAN AND S. H. LEBOWITZ.

(Contribution from the Laboratory of Qualitative Analysis, College of the City of New York.)

INTRODUCTION.

The "brown ring" test for nitrates has been found inadequate in our laboratory, owing chiefly to its failure to supply quantitative indications. In searching for a suitable substitute for this test, it seemed to the authors that the test depending upon the action of sulphuric acid on a nitrate in the presence of copper, offered the best possibilities. Accordingly, this investigation was undertaken with the following aims :—

(1) To determine the best conditions for conducting the test;
(2) To determine the sensitiveness of the test under these conditions;
(3) To determine whether or not the test would give quantitative indications;
(4) To supply a procedure which would be applicable to mixtures of nitrates, nitrites, and acetates.

PART I.—QUALITATIVE.

Our first task consisted in determining the influence of various concentrations of sulphuric acid on the sensitiveness of the test. Pure concentrated sulfuric could not be employed, because when heated with copper it reacted according to the following equations :—

$$Cu + H_2SO_4 = CuO + H_2O + SO_2$$
$$CuO + H_2SO_4 = CuSO_4 + H_2O$$

After considerable experimentation in which the test was performed under many varied conditions, the following procedure was found to give the most sensitive test.

Procedure I.—Dissolve the substance in a test-tube with 1 cc. of water. Add to this solution one-half gram of fine copper punchings which should be clean and bright. (Note 1.) Add 1 cc. of pure conc. H_2SO_4 (Note 2), heat the solution to boiling and boil slowly (Note 3) for one minute.

The above procedure was applied to solutions containing varying amounts of nitrates. The results obtained are given in Table I.

TABLE I. PROCEDURE I.

No.	NO_3 as $NaNO_3$.	Color of Solution.	Gas given off.
1	10	Pale blue	NO_2
2-3	5	Pale blue	NO_2
4-6	4	Pale green-blue	NO_2
7-9	3	Pale green-blue	NO_2 slight
10-12	2	Pale green-blue	No visible gas
13-16	1	Very pale blue	No visible gas
17-19	0	Colorless	No visible gas

Notes.

1.—Copper punchings, if not bright, may be cleaned by boiling with sulphuric acid (1 : 1), decanting the acid and then washing the copper with water. Copper so pre-

pared, should be used immediately while still wet.

2.—The final concentration of the H_2SO_4 is (1 : 1).

3.—The solution is boiled slowly to prevent the sulfuric acid from becoming too concentrated.

Comments on Table I.—

The solutions of $Cu(NO_3)_2$ finally obtained showed a definite gradation in colour, the intensity of the coloration being proportional to the amount of nitrate present. The limit of sensitiveness of the test is 2 mg. One milligram may be detected on comparison with a blank.

Since the final result in the test is a blue coloration due to the presence of copper ions, it was believed that the sensitiveness of the test would be materially increased by making the final solution alkaline with NH_4OH. The complex copper ions thus formed would by their intense color reveal smaller quantities of copper than would the simple Cu ions and hence detect correspondingly smaller quantities of nitrate. Procedure 1 was therefore modified as follows :

Procedure II.—Carry out Procedure I completely. Then decant the liquid from the excess copper into another test-tube. Add slowly, with cooling, 5 cc. of conc. NH_4OH. This amount provides an excess and completely converts the copper into the complex ions. Table II. gives the result obtained with this procedure.

No.	NO_3 as $NaNO_3$ Mg.	Color of the final solntion
1	10	Deep blue
2-3	5	Fairly deep blue
4-5	4	Pale blue
6-14	3.1	Pale blue
15-22	0.5 - 0.3	Greenish-blue
23-26	0.1	Very faint greenish-blue
27-30	0.0	Very faint tinge of green
31-34	0.0	Colorless

Comments on Table II.—

The copper ammonia solutions showed a definite gradation in color, the intensity increasing as the amount of nitrate increased. From Table II. it may be seen that the practical limit of sensitiveness of the test is 0.3 mg. One-tenth of a mg. of nitrate may be detected, but only on comparison with a blank.

Part II.—The Rough Quantitative Estimation of Nitrates.

solutions obtained in the qualitative tests with decreasing amounts of copper suggested to the authors the possibility that the reaction ,as carried out in the qualitative procedure, might proceed quantitatively. The fact that the qualitative test yielded a solution containing copper ammonia ions, suggested the use of a volumetric method based on the bleaching action of a standard solution of sodium cyanide. After numerout experiments the following procedure was adopted :—

Procedure for the Rough Quantitative Estimation of Nitrates.—To one cc. of the solutiou contaiuing the NO_3 as $NaNO_3$, 0.5 g. of copper punchings and 1 cc. of conc. H_2SO_4 are added. The mixture is then heated to boiling and boiled gently for 1 minute. The solution is then decanted from the excess copper into a 250 cc. beaker. The residue of copper is washed with 10 cc. of water and the washings are added to the solution in the beaker. The solution is now exactly neutralised with 10% NaOH. Six cc. of conc. NH_4OH are then added, the solution diluted to 150 cc. and finally titrated with a solution of NaCN (approximately 10 g. per liter) until it is decolorised. The results obtained by this procedure are given in Table III. below :—

Table III.

NO_3 as $NaNO_3$	*Cc. of NaCN solution needed to decolorise the final solution.*
5	2.15
10	3.90
25	10.55
50	21.50
100	43.45

Comments—

Numerous repetitions of the above experiments gave substantially the same results, conclusively demonstrating that the procedure is capable of rougbly estimating the amount of nitrate present.

Part III.—Detection of Nitrates in Mixtures Containing (*a*) Acetates and (*b*) Nitrites.

(*a*) *Interference of Acetates.*—The presence of 500 mg. of acetate was found to interfere with the qualitative test as given. After numerous experiments, the following modified procedure was devised, and was found capable of detecting 0.3 mg. nitrate

Modified Procedure in the Presence of Acetates.—To the solution containing the mixture dissolved in 2 cc. of water, add 0.5 g. Cu punchings and 2 cc. of conc. H_2SO_4. Heat to boiling and boil gently for one minute. Decant the clear solution and to it add 10 cc. of conc. NH_4OH.

(*b*) *Interference of Nitrites.*—We first attempted to destroy nitrites by adding urea to the acid solution. Our experiments showed that even when present in excess of the theoretically required amount, urea failed to destroy all the nitrite. We next tried NH_4Cl. It was found that while this substance destroyed nitrites, that a test for nitrate could not be obtained even when the nitrite was added to the solution after the destruction of the nitrite, showing that chlorides interefere with the Cu-sulphuric acid test for uitrates. This difficulty was finally overcome by the use of $(NH_4)_2SO_4$ in place of NH_4Cl. After much experimenting the following procedure was devised and found satisfactory :—

Procedure for Overcoming the Interference of Nitrites.—In a 250 cc. casserole dissolve the mixture of salts in 4 cc. of water. Add 10 cc. of water and 1.5 g. $(NH_4)_2SO_4$ (This provides an excess over the amount necessary to react with 500 mg. NO_2.) Heat the solution to boiling and boil down almost to dryness; i.e., until the residue consists of moist crystals. Now add 10 cc. of water. With the aid of a rubber tipped rod, rub down the sides of the casserole and boil down again to moist crystals. Take up with 2 c.c. of water, transfer the solution to a test-tube, add 0.5 g. Cu punchings and then 2 cc. of conc. H_2SO_4. Heat to boiling and then boil geutly for one minute. Decant the solution into another test-tube, add slowly, with cooling, conc., NH_4OH until 10 cc. have been added. The results obtained by the above procedure are given in Table IV.

TABLE IV.

No.	NO_3 as $NaNO_3$ Mg.	NO_2 as $NaNO_2$ Mg.	Test.
1.7	0	500	Faint greenish blue = to test given by 0.5-1.0 mg. NO_3.
8-10	1	0	Faint greenish-blue
11-13	2	0	Faint blue
14-18	2	500	Faint blue
19-21	0	0	Very slight green-blue
22-24	0.5	0	Fainter green-blue than Exp. 1-7

Comments

The results in Table IV. clearly show that 2 mg. of nitrate can be reliably detected in the presence of 500 mg. of nitrite. From Experiments 1-7 it is evident that the test for nitrite mixtures can be considered positive ,only when the final solution in the test is more intensely coloured than that given by one- milligram of nitrate.

SUMMARY.

1.—The most favorable conditions have been established for carrying out the test for nitrate by means of a mixture of copper and sulphuric acid.

2.—By making the final solution alkaline with NH_4OH, the test has been demonstrated to possess a sensitiveness of 0.3 mg. NO_3. When controlled by a blank the test is capable of detecting 0.1 mg. NO_3.

3.—A reliable procedure has been devised for the application of the test to mixtures of nitrates and nitrites. The method is capable of detecting with certainty 2 mg. of nitrate in a solution containing 500 mg. nitrite.

4.—A method has been provided, on the basis of this test, for the rough estimation of nitrates in qualitative analysis.

New York City, N.7.

A NOTE ON CALCULATED X-RAY LINES.

By F. H. LORING.

In the *Chemical News*, November 27, 1925, p. 338, the present writer gave a series of calculated wave-lengtbs for elements in the incompletely-explored region of the periodic table. Some of the values were not fully worked out, but it is an easy matter to make the calculations from the basic data given.

Attention is here drawn to the line wave-lengths for polonium, or radium F, of atomic number 84, and radium (88). M. Siegbahn and E. Friman (*Phys. Zeit.*, 1916, 17, p. 61) when working with very small quantities of material—in the case of radium one-tenth of a milligram—obtained the following X-ray lines :—

Ra $L\alpha_1$ 1.010, Po$L\alpha_1$ 1.109, Po$L\beta_1$ 0.920.

By the writer's method the calculated values are, respectively, 1.002, 1.1108, 0.9192.

It will be seen that the measured value for

It is of interest to note that the $L\beta_1$ line of Po was registered, whereas the corresponding line of Ra was not. The α_1 line of radium was very weak and this may account for the β_1 line not appearing.

Kaye, in his " X-Rays," 1923, gives the values :— 1.010, 1.109, 0.920. De Broglie in his " X-Rays," 1925 (and earlier French edition), gives values :— 1.010, 1.101, 0.920.

For an approximate curve method for arriving at the above proper wave-lengths, see *Chemical News*, November 6, 1925, p. 289. All the values are in Angström units, as before.

Incidentally, when drawing or inking-in, a curve that is nearly a straight line, as one often does to check calculated values, or for purposes of extrapolation, a wax-taper will be found most useful. This can be pinned along one side to the drawing-board by using tiny pins. It can be very accurately curved without becoming kinked. For curve drawing of the kind indicated, the writer finds it superior to any other method. If necessary the wax can be scraped in places, but usually the pinning down can be done with sufficient accuracy.

ELECTROLYTIC WATER.

By Robert Saxon, B.Sc., F.C.S.

Plain drinking water under the influence of the electric current has a powerful action on metals as anodes and on loose unattached metal on the floor of the cell. Those substances which do not conduct electricity such as sulphur and phosphorus are unattacked, but elements more basic as selenium, tellurium, arsenic are slightly oxidised by electrolytic water. Carbon, silicon, and titanium are more vigorously oxidised, to carbon monoxide, silicic and titanic acids as cloudy gels. Copper gives the hydrate, as does cobalt. Nickel gives a mixture of green hydrate and oxide, iron the hydrate, chromium ,hydrate and green oxide, tin the hydrate, aluminium the hydrate as well as zinc which afterwards gives only oxide. All these are obtained with the metal unattached, resting on the floor as an *idle electrode*. When made the anode the metals copper, nickel, cobalt, iron, aluminium, and tin give the hydrate principally copiously. Zinc gives an abundance of white oxide; nickel, of blue hydrated oxide with very little water in its composition. This is very dark blue. Chromium quickly becomes golden in colour from a covering of CrO_3 the red oxide, and the liquid becomes yellow from traces of chromic acid. Litmus is quickly reddened and if alkali is added and the action continued, sufficient potassium chromate may he made to be gathered and examined after evaporation. There seems to be little or none of the sesquioxide Cr_2O_3, unless the heat used in evaporation is too keen. With finely divided metal it is possible to get a seven or eight per cent. solution of potassium or barium chromate with two hours' electrolysis. With aluminium, tin, or zinc, little or no gas is evolved at the anode, and these are examples of the *corrosive power of electro-ionised water.*

LOW TEMPERATURE CARBONISATION.

A Consideration of Processes for the Production of Free-Burning Smokeless Fuel Involving the Mechanical Compression or Briquetting of the Charge Before or During Carbonisation.

By David Brownlie, B.Sc. (Hons.), Lond. F.C.S., M.I.Chem.E., A.M.I.Min.E., etc.

(Paper recently read before the South Wales Institute of Engineers, Park Place, Cardiff.)

The contribution is of great length, over 40,000 words, and includes 19 illustrations, while the author, who summarised the paper in about 45 minutes, showed over 50 specially prepared lantern slides, including many photographs of the plants described.

The author stated that for over 75 years past inventors have endeavoured to treat coal by methods involving carbonisation so as to obtain the maximum yield of liquid products ,although what is generally termed " low temperature carbonisation " for the specific purpose of the production of a hard free burning smokeless fuel can be said to have started with Thomas Parker, of " Coalite " fame, in 1890, that is, simple heating of the charge at 1,000° F., instead of 2,000° F. To-day, it was pointed out there are well over 100 processes, represented by hundreds of patents, that come within the scope of low temperature carbonisation, so as to obtain the maximum yield of valuable by-products, particularly of a liquid character, in a manner different to the existing high temperature carbonisation processes of the gas works and the coke oven. One of the great difficulties is to

bring together and classify the vast amount of information available, and in the present paper the author has therefore dealt more or less fully with one section of low temperature carbonisation only, that is, processes for the production of a hard free-burning smokeless fuel which involve the actual mechanical compression or briquetting of the charge before or during carbonisation, giving much original information of a historical character and details of various processes that have not hitherto been published.

The author emphasised that the whole subject of low temperature carbonisation is of vital importance to the British colliery industry, which, in his opinion, ought to have co-operated on the matter years ago, and established a large central organisation for detailed study, including the systematic collection of information, general research work and the try-out on a large scale, with plants of at least 500 tons per twenty-four hours capacity at selected centres, of a number of the most important processes available. The net cost, spread out amongst all the collieries in the country would be a small matter compared with the advantages to the whole industry, and sooner or later Great Britain will be forced to treat her raw coal on scientific lines or cease to be a first-class industrial nation.

The British colliery industry has every opportunity to take the lead as regards scientific methods for the utilisation of raw coal especially since the country is peculiarly well suited in respect to vast deposits of rich bituminous coal aud, on the average, comparative short distances of railway travel between the coal fields and the industrial centres. From a national point of view also, extensive low temperature carbonisation and the more efficient utilisation of raw coal are vital because Great Britain has comparatively little water power and no home supply of liquid fuel. Further, it will be essential in the very near future to develop the home resources of Great Britain in every direction, especially as regards the cultivation of the soil, amongst the most fertile and well-watered in the world, for which fixed nitrogen is essential, and for these reasons coal will become more than ever a key industry.

It is well-known that methods of low temperature carbonisation involving compression or briquetting of the charge give a free burning smokeles fuel because of structure, even when the volatile content is less than 8 per cent., just as charcoal is free burning because it is built up of small cells of even size with free cell walls. The scientific pioneer in the modern scientific of fuel structure in relation to carbonisation is Professor S. W. Parr, of Illinois University, U.S.A., whose work on the subject commenced in 1902. Considerable reference, however, is given to the investigations of early workers in this field whose memory to-day has been forgotten, such as James Palmer Budd, of the Ystalyfera Iron Works, Swansea, who carried out coal blending in 1850 in the most modern principles, Joseph Souquire, of Paris, 1859, blending coal with coke breeze, and John Bethell, of Llanelly, 1854, in connection with the carbonisation of a blend of non-coking coals with pitch. The paper is divided into the following sections :

(1) Mechanical compression of the viscous charge during carbonisation. Including reference to the work of the earlier investigators, Thomas Russell Crampton, Professor S. W. Parr and Paul Naef, as well as the " L. L. Summers " continuous coking process, and H.M. Fuel Research Board. Also particularly the researches of Franz Fischer at Mulheim and the development of the three modern German processes based upon it — those of " Dobbelstein," " Raffloer," and " Meguin."

(2) Briquetting by means of a pitch or other externally produced binder, followed by carbonisation. A brief description of the early history of briquetting, the work of Professor S. W, Parr, R. W. Pringle, and L. S. Richards, Paul Hein, and the Lignite Utilisation Board of Canada, amongst others, and particularly the Smith ' Carbocoal," the " Midland Coal Products," and the " Sun Fuel " processes.

(3) Briquetting without pitch or other externally produced binder, followed by carbonisation.
   - *a* High pressure briquetting processes, including a note on brown coal in this connection, the work of Professor S. W. Parr, Otto Dobbelstein, E. V. Evans, H.M. Fuel Research Board, and particularly the " Pure Coal Briquette " process.
   - *b* Use of a colloidal binder made from the coal itself or any other carbonaceous material according to the new German " Delkeskamp " process.

As regards the compression of the viscous charge during actual carbonisation to give a hard and close grained fuel work in this field dates back to about 1870 and Professor Parr first studied the principle in detail. Allied to this is L. L. Summers' continuous coking process, of New York, in which the charge travels through a long narrow firebrick oven by means of a reciprocating iron floor with a projecting fin at one end, the charge being subjected to very considerable compression. The modern work in this field for strictly low temperature carbonisation is based on the investigations of Franz Fischer and includes in the first place the process of Otto Dobbelstein ,of Essen, Germany. This consists of the mechanically continuous production of hard smokeless low temperature fuel with carbonisation at about 1,022° F. (550° C.) for 4 hours, using a special horizontal cylindrical retort built up of alternate transverse thin steel cells 2 to 3 inches wide and heating chambers 4 inches wide with a loose internal roller ram feed and compression of the charge.

Equally remarkable is the process of E. Raffloer, of Duisberg, Germany, also for the mechanically continuous production of hard smokeless low temperature fuel with carbonisation at about 842° F. (500° C.) for one hour, using a special horizontal cylindrical retort externally heated, and divided inside into a series of long parallel narrow channels or gutters filled with the charge, operated with reciprocating rams and also having a loose heavy roller for compression.

Lastly, in the Meguin A.G. process, of Butzbach, Germany, two concentric vertical retorts are used, rotating at relatively high speeds so that the viscons charge is compressed up against the inner surface of the outer cylinder by centrifugal force.

With regard to the question of low temperature processes depending on the carbonisation of briquettes made in the ordinary way with pitch, this method has also been investigated for many years past and one of the best-known processes is the "Smith Carbocoal" which was operated between 1920-1922 on a very large scale at South Clinchfield in Virginia, U.S.A., at one time attaining an output of 600 tons per 24 hours. The plant, however, was closed down and the process is now being thoroughly investigated by Charles V. McIntire, of New York. It consists essentially in carbonising for 2½ to 3 hours, bituminous or semi-bituminous coal under low temperature conditions of 1.200-1.400° F., in an externally-heated horizontal retort having an internal screw conveyor. The low temperature fuel is then briquetted with pitch and the briquettes carbonised in a high temperature retort on the externally heated ,intermittent, inclined firebrick type, rectangular in cross section, for 8 hours, at a temperature of approximately 1,800° F.

There is also described the process of the Midland Coal Products, Ltd., of Netherfield, Nottingham, consisting in briquetting small non-coking coals, generally blended with about 30 per cent. coking coal, with pitch as usual and then carbonising the pitch briquettes in a continuous vertical retort, using a blast of steam and air at the bottom to partially gasify the charge, the duration of travel being 5 hours and the maximum temperature zone about 2,190 F. (1,200° C.)

As regards the third method, that of carbonising briquettes without any pitch the best known process is the "Pure Coal" Briquette, primarily the invention of Mr. E. R. Sutcliffe, which is controlled by Sutcliffe, Speakman & Co., Ltd., of Leigh (Lancs.). A plant with a throughput of 100 tons per 24 hours is now almost completed at Leigh, the process depending essentially on briquetting the coal without any binder at high pressures, up to 10 tons per square inch in a new type of briquette press. The "Pure Coal" briquettes are then carbonised in a vertical continuous retort internally heated, generally at a maximum of about 1,600- 1,850° F., by means of a stream of inert gas and steam, the carbonised briquettes being taken out at the bottom after heating for 6-8 hours. The fuel is entirely free-burning, although only containing about 8 per cent. volatile matter, and the oils obtained, 14-20 gallons per ton, are of low temperature composition.

Finally, a very remarkable new process which the author describes in his paper for the first time, is that of Dr. Rudolf Delkeskamp ,of Berlin, in which it is claimed that coal or any other conbonaceous material can be briquetted without any binder, merely using the ordinary simple type of briquette press at 1-2 tons per square inch instead of abnormally high pressures. The principle is entirely novel and uses as a binder merely part of the coal itself, which is ground up with water to a colloidal condition and then mixed in with the bulk of the coal. The resulting briquettes are then carbonised direct without expansion or other troubles, either at low temperature to give

a smokeless free-burning fuel known as "Carburite," or at much higher temperatures to give "Carburite Coke," which is claimed to be much superior to ordinary coke. Any carbonaceous material can be used as the colloidal binder, bituminous, semi-bituminous, and anthracite coal, canneloid refuse, brown coal, lignites and peat can all be converted into bard briquettes by mixing them with any carbonaceous material, blended or otherwise, in a colloidal condition. The process turns on what is the cost of grinding and how much of the fuel in the colloidal condition is required, but it is believed that anything from 6-20 per cent. of the material has to be colloidalised.

A FUNDAMENTAL STUDY OF JAPANESE COAL. PT. III*

By Chozo Iwasaki.

The main object of study in previous papers was the investigation of the microscopic structure of Japanese coal while the study of the chemical composition was largely untouched. The object of this work is to study the coal from the chemical standpoint.

The samples were taken under conditions showing the various stages of coalification, preserving the remains of the original plants and belonging to seams economically workable.

Soya, Miruto and Miike coals are very different in both microscopic and chemical properties, notwthstanding that they are all tertiary. Soya coal shows specially good plant preservation, the Miruto sometimes shows the wood tissues and the Miike represents almost complete humification. The chemical examination included technical and total analyses, forms of sulphur, properties of inorganic matter, calorific value and volatilising grades under different temperatures.

The bright coal contained more sulphur (up to 0.8 per cent. in Soya, 0.6 in Miruto, and 3.6 in Miike). Pyritic sulphur never exceeded 0.1-5%. Free sulphuric acid was present in the mine water and caused considerable corrosion to the apparatus in the Miike colliery and most of the sulphur in the coal is present as sulphate.

The inorganic matter in the coal was investigated from an examination of the ash and from the dilute hydrochloric acid extract.

Table I. shows the composition of the ash.

Table I.

	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	Na_2O	K_2O	P_2O_5	SO_3
Soya, Bright	.12	.47	.09	.44	.06	.06	.03	.01	.32
,, Dull	8.73	.94	3.17	1.05	.19	.15	.22	.06	.48
Miruto, Bright ...	.67	.72	.57	1.02	.16	.03	.01	.07	.37
,, Dull	17.48	.9	6.85	.33	.2	.14	.07	.01	.14
Miike	2.22	.29	1.71	2.1	.36	.09	.05	.03	1.44

An analysis of the hydrochloric acid extract is given in Table II.

Table II.

	CO_2	Fe_2O_3	Al_2O_3	CaO	MgO	SiO_2
Soya, Bright	.06	.4	.05	.36	.04	.05
,, Dull	.15	.78	1.37	.82	.15	.32
Miruto, Bright	.85	.35	.19	1.24	.24	.15
,, Dull	.05	.25	1.61	.13	.0 4	.17
Miike	1.35	.83	.41	2.45	.43	.13

The hydrochloric acid would readily dissolve the carbonates of Ca, Mg, Fe and others, and the hydroxides of any of these metals would also be soluble. A mineral supposed to be a zeolite also dissolved from the Soya coal.

With regard to the distribution of the inorganic matter in the coal it is easy to recognise particles of quartz, calcite or pyrites, but X-ray photographs alone can reveal the lesser or colloidal inorganic bodies in the coal. Soya coal is of recent formation, and the inorganic matter is uniformly distributed through the bright portions. In dull soya it is sometimes possible to see much colloidal matter, but fragments of foreign minerals, *e.g.*, quartz, are few. The bright Soya ash contained most of the ferric oxide. *Silica is one of the most* stable and regular constituents of coal, and

is probably chiefly present as silicates. The alumina concentrates in the dull coal in which ,also, it is more soluble in acid than that from the bright coal. The lime seems to have accumulated in the dull coal, forming a zeolite and the two coals otherwise contain the same amounts of calcium carbonate and sulphate.

Magnesium is equally distributed iu the ashes of both coals, but has probably forming some complicated mineral in the bright variety. Sodium accumulates in the bright, whilst potassium and phosphates accumulate in the dull coal.

The only inorganic matter seen macroscopically or microscopically in bright Miruto was calcite, which filled cross joints. Most of the inorganic matter in dull Miruto was quartz. Some grains were pure, but others were of foreign origin. The silica in the bright coal probably accumulated there during coalification.

Miike consists of dull coal only, and its mineral constituents are arranged in the fluidal form. This consists chiefly of calcite. There is also some gypsum, representing the combined sulphur. Next to lime, silica is the most important inorganic constituent in this coal. It is nearly all present in the form of quartz grains.

A complete analysis of the coals is given in Table III :—

TABLE III.

	Soya	Miruto	Miike
C	51.3	62.77	75.92
H	3.67	4.03	6.06
O	20.31	13.53	3.66
S	.66	.6	3.59
N	1.07	.77	1.22
Moisture	15.85	4.96	1.25
Ash ...	7.43	13.35	8.3
Calorific Value	5013	6612	7847

The values for the dry coals are higher and those for ashless are higher still.

[The work is supplemented by twelve photomicrographic plates of considerable value.]

**Abstracted from the Technological Reports of the Tohoku Imperial University.*

PROFESSOR F .G. DONNAN.

Professor F. G. Donnan, O.B.E., F.R.S., was elected an honorary member of the American Chemical Society on 6th ult.

General Notes.

BELGIAN SUGAR OUTPUT.

The British Commercial Secretary at Brussels has forwarded the following details of sugar output, stocks, and consumption in Belgium during March, as published in the *Moniteur Belge* :—Output of factories, 239,900 kilogs.; production of refineries, 14,006,221 kilogs.; stocks on hand at the end of the month, 138,798,917 kilogs.; and month's consumption, 12,190,578 kilogs.

THE BUDGET, 1926-27.

The Budget of Great Britain for 1926-27 was introduced on Monday into the House of Commons by Mr. Winston Churchill, Chancellor of the Exchequer. The revenue for 1925-26 was £812,062,000 and the expenditure (inclusive of the Coal Industry Subsidy) was £826,100,000, a deficit of £14,038,000. This deficiency was taken from the annual sinking fund of 50 millions, which will be increased for 1926-27 to 60 millions out of the proceeds of new taxation, and the diversion of part of the Road Fund to the Exchequer. From the balance of this Fund (£19,000,000) £17,000,000 is to be taken, and a proportion of the revenue of the Fund, estimated to produce £3,500,000.

BACTERIAL AMMONIFIERS.

The manure problem is, in short, a delicate question.

Science can evidently increase agritural production by discreetly intervening in order to help a rather hard-worked soil, but it cannot integrally replace by synthetic products the fertilizing power of the earth. The fertility of a soil is characterised by the association of algæ, bacterias, various moulds and microscopic organisms.

The salts fix their nitrogen by the biological process of decomposition. These are the bacteria called "ammonifiers," which have the property of transforming nitrogen in the albuminoid state into assimilable nitrogen. Thanks to this natural phenomenon the earth conserve its fertility.

C. Matignon thinks that sooner or later in the near future the exploitation of artificial methods in the manufacture of nitrogen compounds will have to stop in order to give place to microbian reactions. Intensive culture and the use of all sorts of

manures must necessarily after a certain time entirely change the earth's properties.

At the moment the biological nxation of the nitrogen of the air is also being carefully studied.

Briefly, what is sought is to sterilize the earth by certain products that will kill the protozoa which are the unrelenting enemies of the bacteria, so that the field can be left clear for them to accomplish their nutrfying and regenerative action.

That, it must be admitted, is an elegant but rather optimistic solution of the nitrogen problem.—*Chemicals, N.Y.*

NEW ZEALAND TRADE IN 1925.

The external trade of the Dominion during 1925 amounted to £107,718,679, or only about £300,000 less than the record year of 1920. Last year's figures give cause for satisfaction, in so much as there was a fair approximation of exports to imports, whereas in 1920 no less than £61,500,000 was contributed by imports.

MOND PROCESS SULPHURIC ACID.

How this Ontario Nickel Company Re-Claims Escaping Sulphur Gases from Converters.

Coniston, Ont., Canada.—The new sulphuric acid plant at the smelter of the Mond Nickel Co., has been operating for some time. It is claimed that the plant, which is a distinct innovation in the nickel smelting industry of the Sudbury district, has realised the expectations of its designers and is working most successfully. It is the first attempt made by a nickel company to reclaim the escaping sulphur gases from the converters. The plant includes two units, and the total production will be about 25,00 tons a year. The contact process is used for the manufacture of the acid. The operation is described as follows :—

The gas that comes from the converters contains about 6 per cent. impure sulphur dioxide, and is conveyed to the acid plant through a five-foot steel pipe. To clean it it is passed through a large scrubber, and then through a large filter chamber composed of finely crushed coke, which purifies it completely. After leaving the filter chamber, it passes through a series of lead drying towers. In the centre of the building are large electrically operated blowers, which act as the heart of the system. The gas is blown by these fans into large converters packed with platinized asbestos. It enters at the top as sulphur dioxide and, owing to the catalyzing properties of the platinum, leaves at the bottom as sulphur trioxide.

The gas comes in at about 700° F., and is heated to 1,000° before it leaves, then passing to coolers. From these it is blown to cast-iron absorbing towers, packed with pebbles, entering at the bottom and being forced out at the top, a stream of strong sulphuric acid playing on it all the time. The strong sulphuric absorbs the sulphur trioxide gas, forming an acid much too strong for commercial usage, which is diluted to 60° Beaumé or 93.19 per cent. pure sulphuric acid. From the diluting tanks, the acid is blown by compressed air to the steel storage tanks, and from these is is loaded into the tank cars for rail shipments.—*Chemicals, N.Y.*

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

At the meeting held on Thursday, April 29, 1926, at 4.30 p.m., the following papers were read :—

Oxidation and Storage of Glucose under the Action of Insulin. By C. H. Best, H. H. Dale (Sec. R.S.,), J. P. Hoet, and H. P. Marks.

Under the same conditions as those of the following investigation, but with measurement of the absorption of oxygen in addition, it is found that the total quantity of glucose disappearing from the system under insulin is equal to the sum of the equivalents of the glycogen deposited and of the oxygen absorbed. This balance is preserved whatever the relation between the rate of glucose infusion and the dose of insulin injected—whether the blood-sugar rises constantly, falls within normal limits, or falls to a minimum percentage in the course of the experiment.

The conclusion is drawn that all the glucose disappearing under the action of insulin is either oxidised or deposited as glycogen. The fact that, in the normal animal treated with a fatal dose, the end result is often a disappearance of pre-existent glycogen, with concurrent fall of respiratory metabolism, is attributed to the other action

of insulin, in depressing the new formation of carbohydrate in the liver. It is accordingly suggested that insulin in excessive doses produces the same effects as in physiological doses, but with abnormal intensity.

The Fate of the Sugar Disappearing under the Action of Insulin. By C. H. BEST, J. P. HOET, AND H .P. MARKS. Communicated by Dr. H. H. Dale, Sec. R.S.

When the blood sugar of the eviscerated spinal preparation is kept at a high level for from 2 to 5 hours, by the intravenous administration of dextrose, there is no demonstrable change in the glycogen content of the skeletal muscles. When a hyperglycæmia is maintained and insulin is administered, no significant part of the sugar which disappears is stored as a phosphate ester in the skeletal muscles. Under these conditions ,however, there is an increase of glycogen in the muscles sufficient to account for from 40 to 50 per cent. of all the sugar which disappears. When the rate of sugar infusion is so slow that the blood level of the eviscerated spinal preparation reaches a very low level under the action of insulin, and even when this profound hypoglycæmia exists for several hours, the muscle glycogen is not depleted to form some unknown substance. When sufficient sugar has been available there is a recognisable increase in glycogen.

The results obtained with the spinal preparation which has not been eviscerated are similar to those obtained when the viscera are removed.

Hypoglycæmic canvulsions, which are eliminated in the spinal preparation,, produce a great depletion of the glycogen content of the skeletal muscles. This is well shown in rabbits which, after section of one sciatic nerve, receive a fatal dose of insulin. The glycogen depletion occurs only in the normally innervated muscles.

Observations on the Onset of Rigor Mortis.—By J. P. HOET AND H. P. MARKS. Communicated by Dr. H. H. Dale, Sec., R.S.

The precipitate rigor mortis observed in rabbits dying after hypoglycæmic convulsions, or after prolonged thyroid feeding, is not due to the accumulation of the lactic acid, nor to increased acidity of the muscle. The absence of glycogen and the decrease in lactacidogen of the muscle are the determining factors of this rigor .

These facts must be taken into account in any attempt to build a more complete theory, not only of rigor mortis, but also of the much more important phenomenon of muscular contraction, the current conceptions of which have owed so much to the study of rigor mortis.

On the Effects of Beta Rays from Radium upon Division and Growth of Cancer Cells. By J. C. MOTTRAM, G. M. SCOTT AND S. RUSS. Communicated by Prof. A. W. Porter, F.R.S.

Tumours growing in rats were exposed to measured doses of beta rays from radium. After various intervals ,small pieces of the tumours were removed for examination and counts were made of the number of cells in a state of division.

Immediately after a dose of radiation large enough to prevent growth of the cells *in vivo*, many cells were found in a state of division, but very soon the cells in mitosis disappeared. When irradiated tumours were left in the rats for some days after the irradiation, there was some return of cells in division, even after very large doses.

It is suggested that the variation in the results ,according to the interval between the irradiation and examination, is intimately bound up with the varying susceptibility of the cells at different stages in their growth.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The Cause and Elimination of Night Errors in Radio Direction-Finding. By R. L. ROSE-SMITH, Ph.D., M.Sc., Associate Member, AND R. H. BARFIELD, M.Sc., Student.

SUMMARY.

The paper describes experiments which have been carried out with a view to obtaining more conclusive evidence as to the causes of the apparent variations in bearings observed under certain conditions on wireless direction-finders. In the course of the experiments the Adcock " four-aerial " direction-finder has been developed, and with its aid it has been shown that the actual deviation in azimuth of wireless waves is practically negligible. These experiments thus constitute a proof that the variable errors observed on closed coil-direction-finders at night are caused by downcoming waves arriving from the upper

atmosphere and polarised with the electric force in a horizontal plane. The investigation also indicates the possibility of the Adcock system being developed into a practical direction-finder which is free from night errors associated with observations on aircraft transmissions made at a ground direction-finding station.

SOCIETY OF GLASS TECHNOLOGY.

The ninth Annual General Meeting of the Society of Glass Technology was held in Sheffield on April 21. Mr. Walter Butterworth, Senr., M.A., succeeded Mr. T. C. Moorshead as President. The other officers elected to fill vacancies were :—

Vice-Presidents—Messrs. F. F. S. Bryson, N.B.E., M.A., B.Sc., and S. English, D.Sc.

Ordinary Members of Council—Messrs. R. S. Biram; E. A. Coad-Pryor, B.A.; A. Cousen, M.Sc.; W. J. Gardner; C. J. Peddle, M.B.E., D.Sc., F.I.C.

Mr. Joseph Conolly was re-elected General Treasurer, Mr. F. C. Flint, B.S., was appointed American Treasurer, and Prof. W. E. S. Turner, D.Sc., was re-elected Honorary Secretary.

The Annual Report for 1925 showed that there were on the roll at the end of that year no fewer than 237 members who were resident outside the United Kingdom, and these members were drawn from nineteen different countries.

At the ordinary meeting which followed, four papers were presented :—

Note on the Devitrification of a Lead Borate Glass. By C. J. SMITHELLS, M.C., D.Sc.

Specimens of tungsten filaments were prepared for microscopic examination by embedding them in a fused lead borate glass, held in a brass cup, and subsequently grinding to the required section after the glass had solidified. After the specimens had been polished it was usually etched with alkaline potassium ferricyanide solution for about 15 seconds. An examination of a number of specimens prepared during the last five years showed that in certain cases a number of crystals were visible in the glass when viewed under the microscope with vertical illumination. Further investigation showed that the crystals were not visible in the polished specimens, but only after etching. It was found that the specimens could be divided roughly into groups, showing various degrees of devitrification according to the age of the specimen. The observations appeared to illustrate a simple case of slow crystallisation at room temperature, and indicated the possibility of detecting devitrification in other glasses by means of a suitable etching reagent.

A Note on Some Factors Governing the Resistance of Pots to Glass Attack. By J. F. HYSLOP. It had been noted that one series of pots—K1—gave exceptionally long life, and even when removed from the furnace, these pots showed no evidence of excessive wear. Another series of pots—K2—had a satisfactory life, but they showed convincing signs of severe attack. In both cases a standard alkali-lead oxide glass had been used. In order to study the constitution of the pots, small sections were ground and polished, and on exposure to a beam of X-rays, each crystalline phase in the material gave its own precise diffraction pattern. By finding the patterns for known compounds it was comparatively easy to identify the constituents present in the material. The results obtained showed that the matrix was a more potent factor than the grog in determing the rate of attack of a pot. In order to form a highly desirable protective layer it was necessary to have a high alumina content in the clay. If the fired clay had a high percentage of mullite it would tend to form with the glass an intermediate layer of high viscosity. In the case of a composite refractory, such as a pot, the evidence strongly sugggested that a high mullite content was essential in the matrix of the body.

The Behaviour of Sillimanite in Tank Furnaces. By E. A. COAD-PRYOR, B.A.

Comparative tests were made of sillimanite blocks of standard size (24 inches by 18 inches by 8 inches), made by two separate firms. The blocks were built into a tank furnace on the flux line, between the filling on end and the bridge. The tank was run for 24 weeks on an ordinary flint glass, twenty tons of glass being drawn daily. The blocks were carefully removed and examined. It was then found that the sillimanite had been corroded more severely than the fireclay blocks alongside. In the discussion that followed, Mr. W. J. Rees pointed out that with recent well-made sillimanite blocks, much better results could be obtained than those indicated in the paper.

The Detection of Small Amounts of Selenium in Glass. By J. D. CAUWOOD, M.Sc., AND E. J. C. BOWMAKER.

The authors examined Dragendorff's qualitative test for selenious acid and applied it as a basis for detecting the presence of selenium in glass.

Another paper on the agenda was taken as read, owing to lack of time, namely, ...*Note on the Purification of Sand.* By J. T. HOWARTH, M.Sc., AND PROF. W. E. S. TURNER, D.Sc.

THE REDUCTION OF NITROUS OXIDE.

M. L. Nichols and J. A. Derbigny (Baker Laboratory of Chemistry, Cornell University), publish a study of the investigation to determine the mechanism of the reduction of nitric acid, since nitrous oxide is a secondary product of this reduction.

They summarise their experiments thus:

1.—Nitrous oxide is reduced by aqueous solutions of titanous chloride, stannous chloride and sodium sulphite, with the formation of ammonia, hydroxylamine, and nitrogen respectively.

2.—The rate of reduction of nitrous oxide by aqueous solutions of these salts decreases with the increase in temperature.

3.—The rate of reduction of nitrous oxide by aqueous solutions of titanous chloride and stannous chloride decreases with increased acidity.

4.—The rate of reduction of nitrous oxide by aqueous solutions of titanous chloride is catalysed by platinized platinum.

5.—The rate of reduction of nitrous oxide by aqueous solutions of titanous chloride, stannous chloride, and sodium sulphide increases with increase in concentration of the reducing agent.

6.—The probable mechanism of the reduction of nitrous oxide has been suggested.

SPECIAL NOTICE.

All MSS., Books for Review, Business Letters and Communications of every description, should be sent to the offices as under, and not to any other address.

CHEMICAL NEWS, MERTON HOUSE, SALISBURY SQUARE, LONDON, E.C.4.

NOTICES OF BOOKS.

Second Report of the Adhesives Research Committee. Roy. 8vo. paper wpr. Pp. III + 124, with 28 text figs. Price 3s. net. Postage extra. H.M. Stationery Office.

This report is of unusual interest and covers the period of three years since the Adhesives Committee's first report appeared in 1922. The following matters are, perhaps, the most interesting of those described.

A clear step forward in the study of the chemistry of gelatin has been made by the production of a gelatin of very high purity. It appears that the product is not a definite chemical entity, and it is noteworthy that highly purified gelatin is not, as has often been stated, a poor adhesive, but differs very little in this respect from ordinary high quality glues.

A method has been elaborated for the extraction of high grade gelatin from bones in a far shorter time than has hitherto been possible, and should prove of practical value. But an achievement which should have important economic results is the development of a method of extracting an *odourless* and *tasteless* gelatin of high adhesive value by simple treatment from fish skins. This result should point the way to further enquiries which might well lead to great developments, through the elimination of offensive smell and taste in those industries which depend on fish for their raw material.

Investigations designed to throw light on the fundamental nature of adhesion have been undertaken, and have already enabled some tentative conclusions to be drawn as well as indicating the uses to which particular adhesives are specially suitable.

The absence of a reliable method of testing adhesives for timber has long been a serious obstacle, and promising results have been obtained in preliminary trials of a new form of test piece in which the energy absorbed on fracture of the joint is measured. t has also been demonstrated that, provided a small amount of a heavy loading material, such as lead sulphate, is incorporated in the glue, which does not materially affect the strength of the joint, X-rays may form a valuable means of detecting flaws in joints in finished structures.

Finally, research has been continued on the utilisation of castor bean residues, together with colouring substances and fillers such as sawdust, in the manufacture

of plastic materials. Tiles taking a high polish and suitable for flooring have been produced, and use has been found for the adhesive in the manufacture of water paints and distempers. Samples of the products were exhibited in the British Empire Exhibition at Wembley.

Handbuch der Biologischen Arbeitsmethoden. Edited by PROF. E. ABDERHALDEN. Abt. I Chemische Methoden, Teil 1, Heft 4. Pp. 543-926 + XXIV. Lieferung 178. Price, 16 marks 20 pf.

Abt. XI., Methoden zur Erforschung der Leistung des *Pflanzenorganismus Teil 3*, Heft 3. Pp. 467-612. Lieferung 175. Price 6 marks.

Abt. XI., Methoden zur Erforschung der Leistungen des Pflanzenorganismus. Teil 3, Heft 4. Pp. 613-714. Lieferung 186. Price 4 marks 80 pf.

Prof. Abderhalden's comprehensive Handbook on biological and biochemical processes evidently aims at being all-inclusive. We are told that there are to be 600 contributors and every aspect of the wide field is to be surveyed.

The three volumes under review are of more chemical than biological interest. The first opens with an important detailed acccount by Dr. F. Flury, of recent improvements and methods of controlled and safe heating, protection against explosions and fumes, methods of handling corrosive liquids. It includes a list of poisons and antidotes.

Dr. Czapski contributes the second and comparatively brief section on Indicators, treating them individually, giving their preparation, properties and method of use.

The third section is by Dr. Ernst Komm, who deals with the characteristic carbon-nitrogen condensations of carbonyl compounds. Dr. F. Wrede describes the acetylation processes, and Dr. Backer esterification. This last section is the longest of the volume, occupying 140 pages. This volume possesses a contents and a subject index, but no author index. The other two volumes have neither contents nor index, since they are only parts of a larger and uncompleted volume.

Teil 3, Heft 3, of Section XI is entirely devoted to Professor Neubauer's account of the methods of determining the nutrition of plants and analysis of manures and artificial fertilisers—a subject on which the author is well qualified to write. The general method of determining nitrogen in various forms of combination, phosphoric acid, potassium and other constituents are adequately described. Detailed comment is not possible here, but this section should be of considerable value to analytical chemists and others called upon to evaluate fertilisers and artificial manures.

Teil 3, Heft 4, contains three contributions from Prof. H. Luers on the determinations of (1) the titration acidity in plant extracts and similar coloured liquids; (2) the formaldehyde titratable nitrogen in plant extracts, etc.; and (3) pre-existing groups of substances (*e.g.*, acids, nitrogen compounds, carbo-hydrates) in plants.

Prof. A. Koch's brief note (4 pages) on the detection of the assimilation of atmospheric nitrogen is at least interesting. There is also a paper by Dr. W. Kotte on the methods of determining the assimilation of organic bodies by higher plants, but more than half the volume is taken up with Prof. Schroeder's account of the methods of estimating the assimilation of carbon dioxide by plants from the air and from water (water plants).

When the whole Handbuch is complete it will be of great value to biologists and biochemists. It will, however, suffer from the fact that a few years will render it out of date by virtue of further advances.

The U.S. Bureau of Standards has just issued a Circular (No. 279) entitled *Relations between the Temperatures, Pressures, and Densities of Cases*. Price 25 cents.

An attempt has been made to derive the formulæ in a simple manner with the minimum requirements of theoretical knowledge on the part of the reader. The experimental data involving high pressures are presented in such a form that problems of this kind may be solved by introducing factors taken directly from the curves. The significance of the equations of state of van der Waals, Dietrici, and Berthelot are discussed and the manner in which these equations may be used to predict compressibilities is explained in detail. Comparisons of the calculated values with experimental data for various gases are shown by means of a series of curves. There is an extensive bibliography and also many conversion tables.

FORTHCOMING EVENTS

ROYAL SOCIETY OF ARTS.

Wednesday, May 12, at 8 p.m. (Ordinary Meeting). Warre S. Bradley, "Industrial Welfare in Practice." Sir Robert A. Hadfield, Bt., D.Sc., F.R.S., will preside.

ROYAL INSTITUTION OF GREAT BRITAIN.

Tuesday, May 11, at 3 p.m. (The Tyndall Lectures). "The Acoustics of Public Buildings." By W. C. Kaye, O.B.E., M.A., D.Sc.

Friday, May 14, Seton Gordon, B.A. (Oxon.) F.Z.S. "The Golden Eagle and Its Neighbours."

THE INSTITUTE OF METALS.

A General Meeting of the Institute of Metals will be held at the Institution of Mechanical Engineers, Storey' Gate, Westminster, S.W.1., on Wednesday, May 19, 1926, at 8 p.m., when the sixteenth annual May Lecture will be delivered by Professor H. C. H. Carpenter, F.R.S., on "Single Metallic Crystals and their Properties."

THE INSTITUTE OF PHYSICS.

Tuesday, May 11, 1926, at 5.30 p.m., in the Physics Theatre of the Royal College of Science, Imperial Road, South Kensington.

"Public Lectures on Physics in Industry." *No. 10.* "The *Relationship of* Physics to Aeronautical Research." By H. E. Wimperis, M.A., F.R.Ae.S., Director of *Scientific Research, Air Ministry.* A cinematograph film illustrating the Cierva Autogiro will be shown at the end of the lecture.

The chair will be taken by Sir William Bragg, K.B.E., F.R.S., President.

THE FARADAY SOCIETY.

"Explosive Reactions in Gaseous Media." A general discussion on this subject will be held on Thursday, May 13, at the Institution of Mechanical Engineers, Storey's Gate, Westminster, beginning at 2.30 p.m.

PROGRAMME AND TIME-TABLE.

Part I.—Explosive Reactions Considered Generally. 2.30 to 4.30, and 5.0 to 6.30 p.m. Chairman, Professor H. B .Dixon, C.B.E., D.Sc., F.R.S.

1. Dr. W. E. Garner : Introductory Survey.
2. Professor H. B. Dixon, J. Harwood, and W. F. Higgins : "On the Ignition Point of Gases."
3. Professor W. T. David, M.Inst.C.E. : "Radiation in Gaseous Explosions."
4. (1) Dr. S. W. Saunders and W. E. Garner : "*Ionisation in Gas Explosions.*" (2) Communication from Dr. S. C. Lind : "Ionisation and Gas Explosions."
5. Professor R. V. Wheeler and Dr. W. Payman : "The Uniform Movement of Flame."
6. Professor W. A. Bone, F.R.S. : "Explosions at High Pressure."
7. Dr. Colin Campbell and Professor H. B. Dixon : Explosion Wave in Cyanogen Mixtures."

General Discussion.

Part II.—Explosive Reactions Considered in Reference to Internal Combustion Engines 7.45 to 10 p.m. Chairman, Sir Dugald Clerk, K.B.E., D.Sc., F.R.S.

8. Sir Dugald Clerk : Introductory Survey.
9. Professor W. T. David, M.Inst.C.E. : "Combustion in Gas Engines."
10. H. T. Tizard : "Explosions in Petrol Engines."

General Discussion.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

9,755.—Corbould, W. H.—Hydrometallurgical treatment of oxide products of lead, etc. April 13th.

10,086.—Flor, K.—Process for obtaining *sulphur from sulphates of earth* alkalies. April 16th.

9,962.—Hailwood, A. J.—Electrolytic desulphonation of anthraquinone sulphonic acids. April 15th.

9,758.—Ramage, A. S.—Peroxides of *hydrocarbons. April 13th.*

Specification Published.

249,916.—Loon, Dr. C. Van.—Process for *the conversion of neutral or nearly* neutral triglycerides, mutually or with other esters.

249,914.—Petersen, H.—Process of manufacturing sulphuric acid.

249,973.—Green, A. G.—Manufacture of oxidation products of aromatic hydrocarbons by air oxidation.

250,102.—Gulf Refining Co.—Process for removing aluminium chloride residues from vessels used for the catalytic treatment of petroleum hydrocarbons.

244,746.—Chemische Fabrik Von Heyden Akt Ges.—Manufacture of aromatic stibinic acids.

249,717.—Farbenfabriken vorm F. Bayer & Co.—Process for the manufacture of w-aminoalkylamino-naphthalene compounds and substitution products thereof.

237,594.—Akt.-Ges. fur Anilin-Fabrikation.—Manufacture of ortho-oxyazo-dyestuffs and intermediate products thereof.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25 ,Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

247,439.—Alkali silicates.—Norske Hydro-Elektrisk Kvaelstofaktieselskab; 7, Solligaten, Oslo.

Alkali silicates; nitrogen oxides; silica; alkali metal compounds. obtaining from complex silicates. Alkali silicates are obtained by heating a mixture of an alkali nitrate or nitrite or both with hydrated silica such as that produced in the treatment with acids of acid-soluble silicates such as labradorite and leucite, or diatomaceous earth. The heating is effected at a temperature at which fusion does not occur, and the nitrogen oxides are recovered and may be converted into nitric acid which may be used to treat the mineral such as labradorite to obtain more silica. The alkali nitrate employed may be obtained from a natural silicate and nitric acid. The product is a porous mass which may be used as a fertiliser, or it may be treated with water to obtain a solution of alkila silicate.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

RUSPBRITE.

467,488.—Compounds to prevent Rust on Metal.—Industrial Chemicals Co., 38, Moorland Road, Burnley, Lancashire. April 14th.

SPERKIT.

467,229.—Mixed cultures of cellulose-fermenting organisms used for agricultural and horticultural purposes.—Fakaltorf Studien Gesellschaft Mit Beschrankter Haftung, 94, Schnorrstrasse, Dresden, Germany. April 14th.

ICOTO.

467,479.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—W. Stevens & Co., 31, East Hill, Wandsworth, London, S.W.18. April 14th.

A.C.P. RODINE.

467,500.—Chemical substances in liquid form for use in metal pickling, and sold in drums, barrels, carboys, tins or like containers.—American Chemical Paint Co., corner of Brookside Avenue and Reading Railroad, Ambler, Montgomery, Pennsylvania, U.S.A. April 21st.

REOBIL.

467,820.—Chemical substances prepared for use in medicine and pharmacy.—Society of Chemical Industry in Basle, 141 to 227, Klybeckstrasse, Basle, Switzerland. April 21st.

STARS, BARS AND CIRCLE.

466,740.—Anti-corrosive oils and chemical products, for mixing with liquid motor fuel to prevent knocking.—Standard Oil Co., Constable Hook, Bayonne, Hudson, New Jersey, U.S.A. April 21st.

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THE CHEMICAL NEWS,

VOL. CXXXII. No. 3448.

MERTON HOUSE, SALISBURY SQUARE,
LONDON, E.C.4.

TELEPHONES:

Administrative: Central 6521.
Printing Works: Hop 2404.

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A POSSIBLE ERROR IN THE CALC-SPAR ESTIMATION OF HYDROCHLORIC ACID.

By A. C. D. RIVETT.

(Contribution from the University of Melbourne, Australia.)

In the very convenient method of standardising hydrochloric acid solutions by means of calc-spar (Masson, *Chem. News*, 1900, LXXXI., 73), it is usual to add a known volume of acid to a weighed flask containing spar, and after allowing the action to proceed in the cold for a time, to complete it by raising the temperature to the boiling point and maintaining it there for half-an-hour or more. The solution of calcium chloride is decanted off and the flask and crystals well washed, dried and weighed. The loss of spar is equivalent to the acid taken.

It is evident that the method depends for high accuracy (say, within 1 in 1,000) either upon insolubility of calc-spar in carbonic acid solution or, if this is not insoluble, upon the boiling being begun at a stage when there is still enough hydrochloric acid present to react with any dissolved bicarbonate (or carbonate from its decomposition) which may have been formed at the lower temperature. Masson did not at any time find evidence of such formation of bicarbonate although he allowed the action to proceed in the cold for times varying from 3-4 hours to overnight, his solutions all remaining clear on boiling; and similar results have repeatedly been obtained in this laboratory. This is, however, not an invariable rule. There appears to be rather curious variation in specimens of spar and it may be worth while to draw attention to some measurements recently made with some apparently perfect crystals.

That calc-spar does dissolve in a solution of carbon dioxide was easily demonstrated by sealing some lumps in a glass tube with about 50 c.c. of 0.3-N acid and keeping the tube for three days at room temperature with occasional rocking. On opening it, carbon dioxide escaped freely, and on heating the perfectly clear solution a considerable precipitate of calcium carbonate was obtained. This precipitate, examined under the microscope, was highly crystalline, being made up of three distinct forms, long needles (arragonite), rhombs (calcite), and stellar growths of hexagonal structure which were isotropic to polarised light passing at right angles to the flat surfaces exhibited.

In two parallel estimations of a 0.3-N solution of hydrochloric acid by means of spar, where the action in the cold was allowed to proceed overnight, the figures obtained were (a) 0.299 and (b) 0.3014; the difference, 1 in 200, being well beyond the limit of mere experimental error. In the case of (a), the solution remained perfectly clear on boiling, but in (b) a distinct precipitate was formed which, being removed in decanting the solution, accounted for the high result. This precipitate was made up of crystal forms precisely similar to those obtained in the sealed tube experiment, and to those which one obtains on decomposing by heat a clear solution of calcium bicarbonate formed from lime water and carbon dioxide. There could be no doubt that it had been formed by dissociation of bicarbonate.

A second determination with the flask and residual spar from (b), but in which the action of the acid in the cold proceeded for only one hour before heat was applied, gave a clear solution on boiling and a normality of 0.3000. Then two more determinations were made with the original flasks and residual spars, 48 hours being allowed for action in the cold. The respective figures were (a) 0.3000 and (b) 0.3014, and again the solution in (a) was clear on boiling, while (b) gave the same crystalline precipitate as before. With the addition of more spar to (a), a further pair of analyses were made with only three hours' action in the cold and the figures were now (a) 0.2995 and (b) 0.2999.

Why the spar used in the (a) set should have given practically identical results independently of the time of standing with acid in the cold, while that used in the (b) set should have given high results after long standing, owing to bicarbonate formation, one is unable to say. This curious difference is on a par with the fact that of two apparently similar crystals of spar, one will become frosted and another remain superficially quite clear when treated under seemingly identical conditions; in fact, there is probably a connection between the frosting and the formation of calcium bicarbonate. The practical point, however, is that in using spar it is unwise to allow more than a few hours between the times of addition of acid and of heating to complete the action ,if an accuracy of the order of 1 in 1,000 is required.

ELECTROLYTIC WATER.

By Robert Saxon, B.Sc., F.C.S.

Water under the influence of the electric current behaves like an acid, giving with an anode of copper, nickel, cobalt, iron, aluminium, tin, or at the beginning of electrolysis, zinc, the hydrate of the metal. The effect was tried on the sesquioxide of chromium. The *water* contained *no acid, salt*, or *alkali*. The anode of ferro silicon is covered with the oxide. The current is the lighting current through three lamps. The water turns faintly yellow immediately after the current is turned on. This is owing to a trace of chromic acid formed by oxidation. This action is infinitely more feeble than with finely divided chromium instead of the oxide. Manganese dioxide is added, which results in an immediate greening of the liquid, which green liquid two hours later turns yellow on filtering and shows decided evidence of chromic acid after evaporation. The sesquioxide mixed with lime is placed on the anode, while the cathode is placed in water inside a porous pot. Water is poured outside also. Calcium chromate is formed immediately, and proceeds to make for the weaker water inside the porous pot. Potassium hydroxide is next added to a fresh mixture of lime and oxide as before on the anode outside the porous pot. The action is more rapid than before. A mixture of potassium hydrate is next added to a fresh mixture of lime and oxide as before on the anode outside the porous pot. The action is more rapid than before. A mixture of potassium hydrate and oxide also works well. To enlist the aid of double pull, chrome alum is tried along with alkali chlorides. These are used to deliver chlorine thereby oxidising the water, and assisting in the oxidation of the chromium. The reaction is exceedingly rapid and two hours' running sees the formation of potassium chromate principally (with traces of iron hydroxide) sufficient to give residue deeply chrome in colour, and yielding over 3% of potassium chromate after ridding of alumina, and chromite as hydroxides by precipitation.

One result of experiments is that where manganese and chromium oxides are offered the same facility to oxidise and form salts, the manganese makes way for the chromium, allowing it to take up the extra oxygen.

A SHIELDED RESISTOR FOR VOLTAGE TRANSFORMER TESTING.

By Francis B. Silsbee.

(*U.S.A. Bureau of Standards.*)

Voltage transformers are widely used in measuring electric power and energy, and since their accuracy enters directly into the charges for this commodity the need for testing them is apparent. This paper describes the equipment and method used at the Bureau of Standards for testing such transformers over the range from 220 to 30,000 volts. The null method employed is capable of a precision of 0.01 per cent. in ratio and 0.3 minute in phase angle at 60 cycles. The 500,000-ohm working resistor connected across the high voltage is subdivided into sections of 20,000 ohms, each of which is inclosed in a metal shield which in turn is connected to a tap at the proper point of an auxiliary guard circuit. The charging currents from these shields to ground, therefore, flow in the guard circuit

only and do not directly affect the working circuit. A theoretical discussion of subdivided shielded resistors of this type and also of the uniformly shielded type shows that the error arising from capacitance to ground, though greatly reduced by the use of the guard circuit, is not completely eliminated and increases in importance very rapidly as the working voltage of the resistor is increased.

CONCLUSIONS.

From the foregoing it may be concluded that a resistance of 500,000 ohms of the subdivided and shielded type here described can be used on alternating current of commercial frequency up to 30,000 volts with an accuracy approaching 0.01 per cent. or 0.3′.

If the units are constructed symmetrically and if the shields are maintained at a potential midway between those of the terminals of the unit, then (*a*) the current is the same throughout the length of the working circuit and the constants s_k are all zero; (*b*) the phase angle of the circuit is independent of the uumber of units in use.

A single simple measurement of the total capacitance between the resistor and the shield of each unit gives the data needed for computing the effect on the system of any maladjustment of the guard circuit.

An additional measurement of the effective inductance of the units is necessary unless the upper limiting value of $\frac{wr^2C}{4}$ is found to be negligible.

The indeterminate error arising from capacitance from shields to ground is found to increase roughly as the fourth power of the voxltage rating sa that the possibility of indefinitely extending the use of resistors of this type to higher voltages does not appear at all promising, though the present rating of 30 kv. can be considerably exceeded by using larger units, with more effective cooling and with greater temperature rise.

The writer wishes to acknowledge the valuable assistance contributed by many members of the electrical instrument section of the Bureau of Standards during the development of this equipment, and especially to S. Isler, G. T. Morris, J. H. Pim, and W. W. La Rue, by whom most of the experimental and constructional work was done.

THE SYNTHESIS OF ELEMENTS IN THE X-RAY TUBE.

By F. H. LORING.

The writer has been investigating the X-ray spectra of various materials placed on the anticathode of the X-ray tube. The results of these control experiments, for they amount to this, is to show that it is possible for elements of Group VII. to be synthetically formed in the X-ray tube. This is a new experience so far as the writer is aware and before it could be accepted there would have to be a very large accumulation of evidence ;but there is a definite indication of such a possibility, as will be seen from the following.

The first proper indication of this apparent phenomenon happening arose when photographing the X-ray spectrum of an impure sample of potassium phosphate which contained an appreciable amount of calcium and some aluminium as determined by the optical spectrum taken by Messrs. Adam Hilger, Ltd.

The curious feature of this experiment was that the X-ray spectrum of bromine appeared on the plate in the region explored. Three lines can now be identified. This was discussed in a letter which appeared in *Nature*[1]. It was thought that the bromine spectrum arose from the greater sensitivity of the photographic emulsion when wavelengths fell on the plate that were close to those of the bromine atom of the emulsion, although intrinsically weak; but this view is now believed to be in error, and a better one is suggested, namely that the element *bromine* has been formed from calcium and potassium known to be present in the compound which was melted on the anticathode. The following scheme lends support to this view.

Valency.	Element.	Mass. No.		At. No.
1	K	39	41	19
2	Ca	40	40	20
Group VII	Br	79	81	39-4=35
1	K	39	41	19
2	Ni	60	60	28
Group VII	43	99	101	47-4=43
1	Rb	85	87	37
2	Ca	40	40	20
Group VII	I	125	127	57-4=53

1	Cs (or Rb)	133		55
2, &c.	Cr (or Mo)	52		24
		—	—	—
Group VII	75	185		79-4=75
1	Rb	85	87	37
2, &c.	Te	128	126	52
		—	—	—
Group VII	85	213	213	89-4=85

Cs and Rb are widely distributed in nature (more particularly the latter), and it is possible that a Cs chromate, or more probably a corresponding compound involving Rb and Mo may have been present in the substances placed on the anticathode in some of the experiments. It is to be noted that the atomic weights of such elements as those of atomic numbers 43 and 75 may be slightly irregular as in the case of iodine or tellurium.

It is not suggested that the above scheme is correct in detail throughout, as other combinations might be found that would be equally satisfactory. The scheme is merely worked out to illustrate the principle of mass absorption involved. The 4 subtracted in each case may be taken to represent the electrons entering the new nucleus formed so as to reduce the atomic number, obtained by addition, to the proper value. It seems probable that the number of electrons other than four might be involved if the scheme can be extended.

Control experiments, made with pure substances not containing the impurities required, so far show no abnormal effect[2].

REFERENCES.

[1] Loring, *Nature*, May 1, 1926, p. 662.
[2] Loring, *Chemical News*, April 23, 1926, p. 261; *Nature*, March 27, 1926, p. 448.
Other references are given in the above communications. For valency values, see Loring, *Chemical News*, July 24, 1925, p. 50.

Added Note.—Since communicating the above the writer finds that possibly the potassium contained in the commercial phosphate was recovered from *bittern*, which contains chlorides, sulphates, and bromides of magnesium and potassium; and, since common salt contains calcium sulphate, the presence of bromine and calcium as impurities is to be expected. This observation considerably weakens the above argument. While the optical spectrum did not reveal bromine, this might be expected, as this element is not readily detected spectroscopically. The circumstance, however, remains that it is evidently possible to detect certain impurities by the X-ray method that are not ordinarily revealed by means of the spectroscope. This study serves as a caution not to accept the idea that an element has been artificially produced without exhausting every other possible source; at the same time, the contingency of something new happening is not entirely excluded in this case, for it is difficult to account for the strength of the lines on the basis of a trace of impurity.

THE ACTION OF LIME ON ENZYMES.

By Ronald Leslie Collett, M.A., F.I.C.

(From the Laboratories of the British Leather Manufacturers' Research Association.)

In a previous paper an account was given of work from which the conclusion was reached that bacteria not only did not develop in lime liquors, but on the contrary, rapidly died off, the inference being that it was very improbable that any of the properties of "old" or "mellow" limes were due to bacterial activity.

It remained to be shown, however, whether or not enzymes, derived either from bacteria present on the skins, or from the skins themselves, could become active in the lime liquors.

In every one of the numerous lime liquors examined, including the very old Spanish lime liquors, excess of undissolved lime was present, and the reaction was pH 12.4 to 12.6.

If lime liquors are left exposed to the air for very long periods without the addition of fresh lime, carbonation will occur and the alkalinity may fall very much below this figure. Neither the previous work on bacteria nor that about to be described will then apply, but such liquors would have none of the characteristics of true lime liquors, would not plump hides or skins, and are never used in the trade for liming purposes.

Enzymes may be defined as organic catalysts derived from the cells of animal or plant tissues. They are secreted from these tissues, and by their aid the animals or plants carry out their various vital processes.

The digestive enzymes, pepsin, and trypsin, and the enzymes secreted by bacteria are known collectively as the proteolytic

enzymes, since they bring about the hydrolysis of proteins, with the production of peptones and free amino-acids.

Some enzymes, for example the pepsin of the stomach, work in fairly strongly acid solution, but by far the largest number work in solutions very near the neutral point. No digestive juices present in animals or plants have been shown to have an alkalinity anything like as high as that of lime liquors (pH = 12.4), but in most published work on enzyme action the effects have not been studied in such alkaline liquids. This is principally because the alkali itself produces effects upon the materials used similar to those which would be produced by the enzymes, with the result that the accuracy of the results is masked.

It was thought desirable to ascertain experimentally what happened to various enzymes, the properties of which are known, when mixed with lime, and the following report gives the results obtained. The enzymes examined were :—

Pancreatic trypsin; bacterial proteases; pancreatic lipase; "thrombase"; urease; yeast amidase.

The last two were included in the investigation, since they are known to produce ammonia from the amino-acids set free as a result of the action of the proteolytic enzymes on proteins.

In order to complete the work, a section has been included showing the amount of ammonia which may be produced by the direct action of lime on proteins and their degradation products.

Pancreatic Trypsin.

Northrop has shown that trypsin is rapidly destroyed in alkaline solution.

Ringer has proved that it is inactive in solutions at pH 12.0.

Wilson has shown that trypsin does not digest elastin fibres at an alkalinity greater than pH = 9 or 10; but the specific effect of lime on this enzyme does not appear to have been systematically studied.

This has now been done.

Method.

A 2 per cent. suspension of commercial pancreatin was mixed with an equal volume of milk of lime. At the end of stated intervals of time, portions of the mixture were withdrawn and carefully neutralised (to pH 8) with dilute hydrochloric acid. The whole of the undissolved lime was brought into solution, thus eliminating any possibility owing to adsorption on the surface of particles of solid lime.

The resulting solution was then added to a 0.5 per cent. solution of gelatin at pH = 8.0, a few drops of toluene being added to prevent bacterial action. This was then kept at 37° C., and the activity of the enzyme estimated by Sorensen's formol titration method.

Summary.

Proteolytic and fat splitting enzymes are rapidly inactivated by lime.

"Thrombase" is inactivated, and cannot function at the alkalinity of lime liquors. There is also no evidence that the thrombase system has a secondary proteolytic stage which might suggest that it affects unhairing.

Enzymes which produce ammonia are not active in lime liquors.

Lime itself acting on digested proteins produces considerable quantities of ammonia.

(*Abstracted from the Journal of the International Society of Leather Traders' Chemists.*)

THE INFLUENCE OF METALLIC ELEMENTS ON THE CORROSION OF IRON AND STEEL.

By Yuhatirô Utida and Makoto Saitô.

From the technical point of view, it is very important to obtain a ferrous metal or alloy, which has a high resistivity against corroding action of various media. Concerning this problem, numerous investigations have already been made and various non-corroding alloys, such as high nickel steel, stainless steel, etc., discovered. A systematic study on the corrosion of iron and steel alloyed with various special elements were made by Messrs. Newton Friend, Leslie Aitchison, Robert Hadfield, and W. H. Hatfield and many other investigators.

The present work was commenced to study systematically the influence of various metallic elements on the corrosion of iron and steel in acids, as well as the oxidation in atmospheric oxygen at 1,100° C. It is here to be noted that in all cases, special elements were added in the range of concentration forming a solid solution with the mother alloys.

The specimens used in the present investigation may be classified into two series :—

(1) Iron containing a small amount of carbon and varying proportion of one

(2) Iron containing a constant percentage of carbon and varying two other elements.

The authors work out several experiments, giving elaborate formulæ and tables.

SUMMARY.

The general summary of the results of our experiments is as follows :—

(1) The resistivity of cast specimens of iron or steel containing special elements against the acids was studied. The corrosibility is not the same for three acids tested. For example, specimen containing chromium has a least corrosibility in 10 per cent. nitric acid, but it is easily corroded by hydrochloric acid of the same concentration. Nickel and silicon give a high resistivity to the corrosion of iron against the acids.

(2) It is very interesting to see the combined effect of nickel and chromium contained in iron with a small amount of carbon on the corrosion of these acids. Iron containing chromium is easily corroded by the hydrochloric acid and that containing nickel resists very strongly against the same acid; but the combined effect of the two elements on the corrosion give a better result than that obtained by the specimen containing one of these elements. In the case of the sulphuric acid, the same results are also obtained. The combined effect of nickel, chromium and carbon shows that in hydrochloric acid, the better results are given by increasing carbon when it is contained in the range of 0.1 to 0.7 per cent. and in the sulphuric acid, 0.3 per cent. carbon give the best results.

(3) The corrosibility in mixed acids is considerably greater than that in pure acids. Generally speaking, alloys containing high chromium and nickel and a low carbon have a high resistibility against pure and mixed acids.

In conclusion, the present writers express their cordial thanks to Professor K. Honda, under whose direction the present work was carried out.

Science Reports,
Tohoku Imperial University.

General Notes.

CANADIAN FISH OIL INDUSTRY.

The fish oil and fish products industry has developed so rapidly this year that it is expected that three coastwise vessels will be fitted as tankers to carry oil from the *reduction plants.* Last year one vessel experimented in this method and found it successful. It is estimated that 10,000 tons of fish meal and fertiliser and a large quantity of oil will be produced in provincial fish reduction plants this year.

BUSINESS CONDITIONS, APRIL, 1926.

FEDERATION OF BRITISH INDUSTRIES' OPINIONS.

Money.—There was no appreciable inflow of gold during the past quarter, with the result that our stock of gold is nearly £9,000,000 less than it was at this time last year. Bank deposits have fallen £60 millions during the same period, while advances are up £29 millions, bringing the ratio of advances to deposits up to 54.9 per cent. In pre-war days this ratio would have been regarded as indicating that many of the Banks had reached the limits of their lending capacity. That this may well be the case in regard to certain Banks is confirmed by the rumour that one of the big Joint Stock Banks has made a private purchase of gold for its own cash reserves. But even though there may be some seasonal increase in deposits during the coming quarter, it is difficult to see how advances can be increased above their present level without some fairly substantial addition to the gold reserves of the Bank of England.

Production.—There has been a moderate increase in trade during the past quarter. This is due to two factors. This improvement has not been confined to the major industries, but has been widely diffused. It is reflected not only in such general indices of trade activity as railway receipts and clearing house advances, but also in the records of such trades as boots and shoes, chemicals, clothing as well as in important sections of the engineering industry.

In world trade the present year is likely to be one of readjustment and consolidation rather than expansion. Even in America where there are so many factors favouring a continuance of prosperity, there have been signs of the slackening in the momentum of business which we anticipated. It is to be hoped that the recently-announced reduction in the New York Federal Reserve Board rediscount rate indicates a determination on the part of the American Banking authorities to keep liquidation at a minimum, as on their ability to do this must largely depend both the possbility of a reduction in our Bank Rate during the next few months and an improvement in our international position later in the year.

POLYTECHNIC APPOINTMENT.

Mr. H. Lambourne, M.A., M.Sc., F.I.C., has been appointed Head of the School of Chemistry at the Polytechnic, Regent Street, London, in succession to Dr. E. C. Edgar ,who has been appointed Principal of the Rutherford Technical College, Newcastle-upon-Tyue.

Mr. Lambourne was Senior Lecturer in Organic Chemistry at the University College, Nottingham, from 1919-1924, and from 1924 until the present time he has held the post of Head of the Chemistry Department of the Borough Polytechnic Institute.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

At the meeting held on Thursday, May 6, at 4.30 p.m., the Bakerian Lecture was delivered by Prof. A. S. Eddington, F.R.S., on *Diffuse Matter in Interstellar Space.*

SUMMARY.

An attempt is first made to estimate the density, temperature, and state of ionisation of gaseous matter diffused through the stellar system. It is concluded that density is about 10^{-24} gm./cm.^{3}, temperature 10,000°—20,000°, and that atoms are ionised down to 15-20 volts.

The black-body temperature of space is about 3°, but analysis of the processes of interchange between radiant energy and capture form the main process; and this tends to raise the temperature to the level of effective temperatures of stars independently of dilution of radiation. (Hottest stars must be given greatest weight.) Against this, temperature is lowered appreciably, but not excessively, by radiation of electrons at encounters without capture (orbit switches). Temperature of diffuse nebulæ will be same as that of general interstellar gas. This temperature cannot be found accurately because it depends on distribution of stellar radiation far in the ultra-violet, where it is rash to apply the black-body law; but it is as likely to exceed as to fall short of estimate.

An upper limit to density (about 10^{-23}) is obtained from dynamics of stellar motions; gravitational effect of greater mass would make speeds of stars greater than observed. The more definite estimate (10^{-24}) is based on extension and distribution of condensations of medium (diffuse nebulæ) by application of the theory of equilibrium of an isothermal gas. It is concluded that the central density of a diffuse nebula of typical size is about 10^{-20}.

The usual equilibrium formula for amount of ionisation is modified to apply to matter in a field of "evenly diluted" radiation. Calcium is found to be mainly doubly ionised, but there is sufficient singly ionised calcium to give H and K absorption in distant stars. Assuming that the abundance of calcium is the same as on the earth, and using Milne's determination of the monochromatic absorption coefficient, the first calculation gives an H and K absorption of 1 mag. per 100 parsecs. Neutral calcium is nearly a million times weaker. Sodium is mainly singly ionised, and the first calculation gives D lines of neutral sodium about 1/100 strength of H and K lines. Corrections are indicated which would make calcium absorption weaker and sodium absorption stronger, and it appears that the results are consistent with appearance of H and K and slightly weaker D lines in stars distant 500-1,000 parsecs. If the light passes through a nebulous condensation, the required distance is reduced.

These results are compared with the phenomenon of "fixed" sodium and calcium lines which, according to Plaskett's investigation, must be ascribed to an interstellar cloud. Arguments associating the phenomenon with stimulation or emission of matter from star showing the lines, appear to be untenable. It is considered that absorption occurs evenly along light-tracks; but it is recognised that limitation to stars of type earlier than B3 is not very satisfactorily explained. In most stars of later type (where fixed lines are not marked by stellar lines) the absence may be ascribed to insufficient distance.

Dimming of distant stars by interstellar gas would be caused chiefly by electron scattering, but it is found that this is insufficient to produce observable effects. It is considered that the absence of any reddening of distant stars is no evidence of transparency of space. It is found impossible on the present theory to explain obscuration of stars by dark nebulæ, and the question arises whether we must not admit that these contain non-gaseous (meteoric) matter, in order to account for their opacity.

Accretion of mass by stars moving *through interstellar medium must in general* be very much less than loss of mass by radiation, so that there is no appreciable effect on rate of stellar evolution. It is suggested, however, that there will be sharp differentiation of those stars which have velocities less than velocity of sound (about 4 km. per sec.). Possibly these may reach a steady mass—a speculation bearing on the association of B type of spectrum with unusually low velocity and with condensations of interstellar gas.

ROYAL SOCIETY OF ARTS.

The following paper was read at the meeting held on March 10, 1926 :—

The Micro-structure of Coal. By REINHARDT THIESSEN, Ph.D., of the Bureau of Mines, United States Department of Commerce.

ABSTRACT.

Coal is easily one of the most, if not the most, important mineral turned to the benefit of man. There are other similar valuable products such as shale oil, petroleum, natural gas and wood; but these are only temporary and supplementary; coal is the foundation and mainspring of present civilisation. The efficiency with which we use coal and the power derived from it is an index to our social, scientific, and industrial progress. It should, therefore, be of interest and value to learn as much as possible about this important substance; let us hope that through a greater knowledge of its chemistry and composition its value may be increased and its service lengthened.

PEAT FORMATION.

Peat is formed in shallow or undrained basins, depressions or plains where conditions for a luxurious plant growth are favourable, and where there is a water level high enough to insure complete submersion and thus prevent complete decay and make possible an accumulation of the semi-decayed plant substances. Such areas are called swamps or bogs according to the prevailing conditions. Many types of swamps and bogs exist, such as the marsh, fen, moor, and wooded swamp. The most important for our consideration is the wooded swamp, as it is, according to all observations, the one most analogous to the swamps which gave rise to the ordinary coals. Many such swamps exist, particularly in the temperate zone. In the United States, especially in the states of Minnesota, Wisconsin, and Michigan thousands of acres are covered with these swamps. The Dismal Swamp of Virginia and North Carolina is also a good example. The vegetation in these swamps consists of a dense growth of moisture-loving trees, such as the white cedar, tamarack, balsam, bald cypress, black ash, black gum, and a few others. However, only a few species grow together in a given swamp, and of these one predominates. We thus speak of the cedar swamp, the tamarack swamp, or the cypress swamp, because the trees after which the swamp is named predominate in that swamp, being associated with only a few of any other species. Shrubs and herbaceous plants are absent or but scantily represented; but a thick carpet of moss and lichens covers the hummocks, fallen tree trunks and the lower parts of the living trees.

The ground, under these conditions, is very wet, and submerged for the most part during the wet season, so that only the higher places or hummocks are out of the water, and these are thoroughly soaked, even during the driest periods.

Few trees maintain their erect positions. Owing to the loose substratum many trees are found reclining at all angles, and from year to year lean over more and more until finally they lie flat on the ground. The wildest entanglement therefore exists which in some parts is almost impenetrable. On the ground we find a number of trees and tree trunks either on top of the ground or partially submerged in a wild array. Between these is an entanglement of dead limbs, branches and twigs on the surface or partially covered up, and between these again a litter of leaves and fragments of woody matter, all in a more or less decayed condition.

HOW AND WHAT THE PLANTS CONTRIBUTED.

Every tree, no matter whether evergreen or deciduous, sheds its foliage once every year. The total amount contributed by this alone is very large. Besides the leaves, trees shed every year a considerable part of their small twigs, contributing in this way a considerable amount of woody material. Also, as a natural sequence of growth, a part of the bark is shed throughout the

year. Spores, pollens, seeds, and scales, though relatively small in amount, are important contributors every year. Secondly twigs, branches, and the larger limbs are torn off by wind, snow and sleet; occasionally whole trees are blown over. Twigs and branches, and even whole trees may be injured and die, and these, owing to decay, sooner or later fall to the ground. The ground on which the trees grow, being very loose, provides an insecure hold for the roots, and the trees lean over more and more till finally they lie flat on the ground, and are covered up either dead or alive by the debris of the following years.

Immediately after the death of the plant, when those functions which protect the plant from the ravages of parasites and saprophytes cease, it becomes a host to both bacteria and fungi. As long as the plant matter remains in the air and in a moist condition, decay proceeds rapidly. Much of it decays completely, but a considerable portion remains in a semi-decayed condition. This part is reduced to all degrees of maceration.

Gradually as the debris of years is added, the debris of former years is buried deeper and deeper, the air becomes more and more excluded and decay slows up. Fungi cease to be able to exist and bacteria alone are active. Finally the debris becomes heavily covered up and comes to lie in a stratum below the average waterline. Air is now entirely excluded and anaerobic bacteria alone can exist.

The Deposit.

Having obtained an idea of the kinds of plants contributing to the bog, how they contribute and the manner of their decay, and of the composition of the surface and the surface layer, it should not be difficult to get an idea of the structure and composition of the deposit itself.

A casual observation of the surface has shown up a profusion of fallen trees and tree trunks and their parts. Between these is a litter of twigs, branches, strips of bark, leaves and needles. Most of this matter is already in an advanced state of decay. A close up view shows us the importance of leaves, twigs, needles, and fragments of woody matter. In digging into the deposit the same constituents are met with in a more advanced state of decay. The real peat is found at a depth of a foot or two below the surface. An examination of the deposit from top to bottom shows that it was all built up in a similar manner and from the same kinds of material.

The whole mass is very wet, containing up to 85% water. It may easily be dug with the spade and moulded like clay. The spaces between the larger components are filled with a fine black mud. When this is examined under the microscope it is shown to consist, not of earthy material, but of the degradation matter of everything and anything that the plants had produced.

The Coalification Process.

The ancient bog was gradually covered up with silt, sand, and clay, which later metamorphosed into rock, while the peat itself was gradually changed into coal of the rank, according to the time and intensity of the coal-forming process, in which it is found to-day. An anthracite went through all the ranks; brown coal, lignite, sub-bituminous, bituminous, semi-anthracite and then finally into anthracite. Bituminous coals went through all the ranks up to bituminous coal, and so on for the rest. Given the required time and proper conditions the brown coals will change into coals of higher ranks.

The factors which determined the rank of a coal are generally assumed to be the geological period during which the coal was laid down, the pressure and the temperature.

Periods of Coal Formation.

There were three main periods during the earth's history, during which conditions were particularly favourable for the accumulation of plant material which has since been converted into coal. By far the most extensive accumulation took place during the close of the Palaeozoic era. During this time most of the important coals of Europe, North America and China were laid down. The second occurred during the Cretaceous times during which the coals of the eastern slope of the Rocky Mountains were formed. The third occurred during the Tertiary times when the brown coals of Europe and the Lignite of the southern part of the United States and the Western Rocky Mountains were formed. Only relatively small amounts of coal were laid down during other geological periods.

The kind of plants from which the coal was formed probably had also something to

do with the kind of coal, but had probably very little to do with its rank. The kinds of plants that contributed to the Palaeozoic coals belonged to totally different families from those that gave rise to the Cretaceous or the Tertiary coals. The coal measure plants consisted chiefly of Calamites, Lepidodendrons, Sigillaria, Spenophylls, certain Cyads like Gymnosperms, and the Cordiates, now either extinct or represented by small plants. The plants contributing to the Cretaceous and Tertiary coals were much like the plants of to-day. The largest proportion appear to have been conifers, some of them very closely related to certain conifers living to-day. Although the families to which the plants belonged during the range of geological periods may have differed widely, their chemical composition is believed to have been quite similar.

Although the time during which a coal was laid down has much to do with its rank, it is by no means the only important factor. Earth movements or earth thrusts which were accompanied by great pressures and raised temperatures, and depth of burial which is also accompanied by an increased temperature, approximately 1 degree for every 70 feet of depth, were the main factors in the transformation of the plant substances into the higher ranks of coal.

Microscopic Appearance of Coal.

In looking over a number of chunks of coal in a pile it will be noticed that the blocks tend to have a prismatic shape. Two of the surfaces of the blocks have been produced along the bedding planes of the coal. Coal cleaves or splits more easily along these planes than in any other directions and we will call these the horizontal cleavage surfaces. These two surfaces tend to be parallel to each other. Next we notice two surfaces that also tend to be parallel to each other and which may cut the horizontal cleavage surfaces more or less at a right angle. These are called the face sides. Finally we have the two other sides of the block which are more irregular. They may be planes or they may be rough breaks, and when planes tend to be parallel to each other, but rarely at right angles to the cleavage surfaces. More often they are just irregular fractures. These are the butt ends of the coal. In examining a block you will also notice a number of cracks or spits or checks running approximately parallel to any of the snrfaces. When striking the lump it is very apt to break along these cracks. These cracks or checks already exist to a large extent in the seam and are of great importance in coal mining, to a large extent determining the lay-out of the mine. The cause of these checks in discussed a great deal by the physical geologist.

The next property to be observed is a peculiar lustre. This property is due to the physical or colloidal nature of the coal and depends upon the light-reflecting nature of certain constituents of the coal. The intensity of this property is in general a measure of the state of metamorphism of the coal; the higher the rank, up to a certain stage, the higher the gloss.

THE PHYSICAL SOCIETY OF LONDON.

Proceedings at the Meeting held on Friday, March 26, 1926, at the Imperial College of Science. Prof. O. W. Richardson, M.A., D.Sc., F.R.S., President, in the Chair.

Obliquity Corrections in Radium Estimation. By Ivor Backhurst, M.Sc., the National Physical Laboratory.

Abstract.

Formulæ are given for obliquity corrections in radium estimation applicable to sources of the shapes most frequently occurring in practice. The effect of scattered radiation is considered and some experimental results obtained shown graphically and compared with theory. Calculated values for a particular case are given by way of example.

Discussion.

Prof. O. W. Richardson complimented the author on a very careful piece of work, which would be of value in industrial measurements.

Dr. E. A. Owen said that investigators using radium will be grateful for the paper, which works out fully the most interesting case—that in which the tube is at right angles to the radium bench—and also the effect of scattering. Radium is usually estimated in a comparatively small room, and near the walls. It would appear that by keeping at a distance from walls the effect of scattering can be reduced by about

one-half, and it is very useful to know the exact figures. It might be well to make clear in the title of the table given in the paper the fact that the figures are tabulated without allowance for the effect of scattering.

Mr. A. F. Dufton (communicated): Mr. Backhurst's experimental results indicate that, owing to the effect of scattered radiation, the formulæ propounded are perhaps more of academic than of practical interest. In practice, the comparison of two radium preparations can be so effected that the obliquity correction is obviated. For example, in comparison with either a tube 4 in. long or a plaque 3 in. in diameter, a concentrated preparation can be placed 1 in. from the axis. At a reasonable distance from the ionisation chamber this displacement compensates for the distribution of the radium and the application of a correction is avoided.

Viscosity of Water at Low Rates of Flow Determined Comparatively by a Method of Thermal Convection. By ALBERT GRIFFITHS, D.Sc., Professor of Physics, Birkbeck College, AND P. C. VINCENT, B.Sc., Research Student, Birkbeck College.

The paper describes a method of determining the coefficient of viscosity of water by measuring the rate of convective flow in a long capillary tube, the driving head being obtained by the difference in density due to a difference of temperature between two vertical columns of water.

The results are in agreement with the conclusion reached in a previous paper by Dr. Constance H. Griffiths and one of us—*viz.*, that the viscosity of water at low rates of shear in glass tubes is apparently not different from that at high rates.

The novel features of the paper appear to be (1) the method of obtaining the driving head; (2) the new method of introducing a coloured index in a closed capillary circuit, and an improved method of reading its position; (3) the almost complete elimination of what may be called the thermometric effect as distinct from the convective effect; (4) the elimination of the small residual thermometric effect from the final calculations.

A demonstration, entitled *Some Simple Experiments with Thermionic Valves*, was given by DR. E. H. RAYNER.

A metal plate or wire, connected to the grid of an ordinary receiving valve operating with 20 to 50 volts on the anode, acts as a sensitive indicator of the presence of an electric field in the neighbourhood. A piece of ebonite or sealing wax electrified by friction will cause an appreciable change in the anode current, when brought within 3 ft., or more, of the conductor connected to the grid. A unipivot micro-ammeter or a reflecting galvanometer suitably shunted forms a satisfactory indicator. If such a negatively electrified object as ebonite is brought close to the grid conductor, the anode current may be reduced practically to zero, a positive charge being attracted to the near parts of the conductor and a negative charge being repelled to the grid. If the rod is quickly removed the anode current may flow momentarily, but cease again for several seconds, then gradually rise to the normal value. This does not happen with all valves, and it may be affected by the degree of insulation of the valve cap. If the electrified rod is removed somewhat more slowly the same valve may not show this second reduction of the anode current to zero, either effect being produced at will.

If a square piece of sealing wax is electrified and placed on a metal plate about 3 in. square connected to the grid, the anode current will be reduced to zero, with a suitable valve and anode voltage. It will gradually rise again to its normal value, which can again be reduced by turning the sealing wax so that another of the four sides touches the plate. Not only can this be done once with each of the four sides, but possibly several times over, the reason apparently being that the wax only touches the plate in a few points and these parts of it only are discharged by contact, and they become again charged by surface leakage from surrounding parts while the other three sides are being experimented upon. This effect was found to work well with a dull emitter valve which would not show the double reduction to zero of the anode current mentioned above.

In order to illustrate possible applications of induced grid electrification, a pendulum with a metal plate about 3 in. square was made to swing over a fixed similar plate with about a tenth of an inch clearance. The swinging plate was electrified by a battery of about 25 to 70 volts, one end of which was connected to the filament of the valve. A reversing switch was placed in the battery circuit, so that the pendulum could be either positively or negatively electrified. As the pendulum swings past

the fixed plate, it affects the potential of the grid and increases or decreases the anode current twice every complete swing, according to the direction of the electrification. By suitably adjusting the conditions a variation of at least 2 : 1 in the current can be obtained. It sometimes happens that the first swing cuts the current down to zero for several seconds. It is not necessary to use such a large condenser as plates of the size mentioned. A horizontal piece of wire 4 in. long projecting from the pendulum at right angles to the plane of its swing and passing over a similar fixed wire connected to the grid, with a clearance of a tenth of an inch or less, can be made to show quite an appreciable effect when electrified to 100-200 volts.

In general the use of a valve as an indicator of small relative displacements of metal surfaces which can be insulated from one another and charged to different potentials, seems to be one of some promise. When used with movements of the order of 1 or less periods a second, leakage in the valve cap becomes an important factor, and experiments of the type indicated are distinctly critical in showing up differences between valves.

GEOLOGICAL SOCIETY OF LONDON.

At the meeting held on April 21, 1926, the following communications were read :—

"*Anthracopupa britannica*" *sp. nov.*, *a Land Gastropod from the Keele Beds of Northern Worcestershire.* By LESLIE REGINALD COX, M.A., F.G.S.

This paper records, for the first time, the occurrence of a Pulmonate Gastropod in British Carboniferous rocks. A few species belonging to the group have long been known from rocks of Upper Devonian and Carboniferous age in North America, but the only previous record from European Palæozoic strata is a single fragmentary specimen from the Lower Permian of France.

The specimens described were collected by Mr. W. Wickham King, F.G.S., in 1924. They were found in a grey calcareous claystone, interstratified with the vermilion marls of the lower part of the Keele Beds, on the northern slope of Clent Hill (Worcestershire).

The shells are about 3 mm. in height; the apertnre of one has been developed clearly, and shows a very prominent parietal tooth, as also a more stumpy tooth on the columella. There is no doubt that the species is a land shell, referable to the family Pupillidæ; it is very close to *Anthracopupa vermilionensis* (Bradley), from the Coal Measures of Illinois, but differs in being slightly stouter, and in the much more acute angle between its columellar lip and the anterior apertural margin.

On a Rock-Building Bryozoan with Phosphatized Skeleton from the Basal Arenig Rocks of Ffestiniog (North Wales). By HERBERT PRICE LEWIS, M.A., F.G.S.

During the last forty years various authors have recorded the occurrence of black, usually ovoid masses in the basal Arenig rocks (Garth rit) on both sides of the Harlech Dome. These masses have been designated "lumps," "pebbles," and "nodules." Their delicate concentric shell-structure has been regarded as due to contraction, and the fractured surfaces as presenting a curious resemblance to Nummulites. Other writers have observed that they show "a number of 'oolitic' grains."

The author, on the evidence of etched surfaces and microscope-sections, has found that the structure of these masses was originally organic, but modified later by inorganic processes.

A new genus is described, and referred to the Ceramoporidæ of Ulrich. This genus is represented by one species—the earliest bryozoan known in British rocks. The species was responsible for the building-up of the nodular masses, which have been proved by analysis to contain a large amount of calcium phosphate.

The stratigraphy of the deposit containing the described fossils is dealt with by Prof. W. G. Fearnsides.

The Geology of the Cayman Islands (British West Indies), and their Relation to the Bartlett Trough. By CHARLES ALFRED MATLEY, D.Sc., F.G.S. With an Appendix on the Species of *Lepidocyclina* and *Carpenteria* from Cayman Brac and their Geological Significance, by Thomas Wayland Vaughan, Ph.D., For.Corresp. G.S.

The Cayman Islands, a dependency of Jamaica, are an isolated group of three islands, with an area of 100 square miles, all very similar in their geological structure and history, although each is a separate faulted block.

The islands are bnilt entirely of calcareous rocks, which are free from terrigenous

materials other than fine dust. There are two formations present, an older Bluff Limestone, and a newer, Ironshore Formation, lying unconformably upon the former, which makes a costal terrace with a maximum height of 12 to 15 feet above the sea.

The Bluff Limestone, a white, massive, semicrystalline limestone, containing casts of mollusca, badly preserved corals, nullipores, and foraminifera, resembles lithologically many parts of the White Limestone of Jamaica. The discovery on Cayman Brac of a bed rich in *Lepidocyclina undosa* Cushman, *L. gigas* Cushman, *L. yurnagunensis* Cushman, and other forms, fixes the horizon in that island as Middle Oligocene, and enables us to correlate it with a zone containing *L. undosa* (associated with *L.* cf. *gigas*), which the author has traced over many parts of Jamaica in the White Limestone.

In Little Cayman and Grand Cayman, the Bluff Limestone appears, from the meagre palæontological evidence obtained, to be of Miocene age; on general considerations, the author thinks that its age there is not likely to be newer than Lower Miocene. The thickly-forested surface of the limestone, which makes an upper platform or plateau on each island, is a karstland in an advanced stage of development. The plateau appears to have been formed by marine planation, and to have developed a slight westward tilt in the course of elevation, so that the western end of each island remained just below sea-level.

On the coastal shelf formed round each island by marine erosion the calcareous Ironshore Formation, with its mollusca and corals of living species, was deposited. Its emergence, in Pleistocene or recent times, as a low platform backed by the ancient cliffs, is considered to be probably the result of a fall of sea-level. It is compared with the Falmouth Terrace of Jamaica and other similar low coastal terraces of the West Indies. The off-shore platform seems to have been subjected to submergence, also due to change of sea-level, and the recent coral-reefs have been formed on this shelf.

The almost completely submerged Cayman Ridge on which the islands stand, and the Bartlett Trough which flanks it on the south, are described and examined in the light of the Wegener hypothesis, and it is suggested that the Cayman Islands and the submerged parts of the ridge may once have lain near the Jamaica-Honduras ridge, with Jamaica itself confronting the Sierra Maestra of Cuba; further, that the separation has taken place by the development of a great crustal fissure (initiated probably in Pliocene, or at the earliest in Middle Miocene, times), which has widened until it has become the Bartlett Trough.

Dr. T. W. Vaughan contributes an appendix on the Middle Oligocene foraminifera from Cayman Brac. He correlates the formation in which they occur with the Antigu Formation of Antigua, the Glendon Formation of the Gulf States, and the Meson Formation of Mexico. Some of the characteristic species are also known from thhe Oligocene of Jamaica and Eastern Cub.a.

ROYAL INSTITUTION.

The Annual Meeting of the Members of the Royal Institution was held on Saturday afternoon, May 1, Sir James Crichton-Browne, Treasurer and Vice-President, in the chair. The Annual Report of the Committee of Visitors for the year 1925, testifying to the continued prosperity and efficientcient management of the Institution, was read and adopted. The Report of the Davy Faraday Research Laboratory Committee was also read. Sixty-two new Members were elected in 1925, and 63 Lectures and Evening Discourses were delivered. The Books and Pamphlets premaking with 567 volumes (including periodicals bound) purchased by the Managers, a total of 821 volumes added to theh Library in the year. Thanks were voted to the President, Treasurer and Secretary, to the Committees of Managers and Visitors, and to the Professors, for their valuable services to the Institution during the past year. The following gentlemen were unanimously elected as Officers for the ensuing year :—

President—The Duke of Northumberland; *Treasurer*—Sir Arthur Keith; *Secretary*—Sir Robert Robertson; *Managers*—Sir Harry Baldwin, Sir John Biles, Sir James Crichton-Browne, John Mitchell Bruce, Viscount Chelmsford, Ernest Clarke, W. H. Eccles, Sir Oliver Lodge, Charles H. Merz, Sir Ernest Moon, Sir Edward Pollock, Sir Arthur Schuster, Sir Henry Wood, Sir Ilmroth Wright and Sir Alfred Yarrow; *Visitors*—K. A. Wolfe Barry, James H. Batty, W. A. F. Balfour Browne,

Charles Carpenter, Alfred Carpmael, Charles J. P. Cave, A. Chaston Chapman, Alexander F. H. Dick, W. Vaux Graham, Sir Lawrence Jones, Ronald Malcolm, Sir Walter Peacock, Hugh Munro Ross, Frank Coston Taylor, and John Tennant.

A General Meeting of the Members of the Royal Institution was held on Monday afternoon, May 3. Sir James Crichton-Browne, J.P., M.D., F.R.S., Manager and Vice-President in the chair. Sir J. J. Thomson was elected Honorary Professor of Natural Philosophy. Miss Lilian Quartly, Sir Henry Maybury, Mr. W. H. Frizell, Mrs. Samuel Courtauld, The Hon. Sir William F. K. Taylor, Mr. G. M. Clark, Mr. Richard M. N. Dawlings, and Mr. Charles S. Gibson, were elected Members.

SULPHUR AND PYRITES IN THE U.S.A. IN 1924.

By Helena M. Meyer.

(*Department of the Interior.*)

Sulphur.

The conditions in the sulphur industry were substantially the same in 1924 as in 1923. While production decreased 40 per cent. during the year, from 2,036,097 to 1,220,561 long tons, shipments decreased only 5 per cent. from 1,618,841 to 1,537,345 tons. Ror the first time since 1920 the shipments were thus larger than the production, and with the exception of those for 1923 they were the largest ever recorded. The excess of shipments over production was drawn from stocks, which at the end of 1923 had reached the unprecedented total of 3,000,000 tons. This left 2,700,000 tons on hand at the mines at the end of 1924, a decrease of 10 per cent. Stocks, however, are still large enough to carry on record shipments, with the mines shut down, for nearly two years. The estimated value of shipments in 1924 is $25,000,000, compared with $26,000,000 for 1923, at approximately the same rate per ton.

As usual, the Texas Gulf Sulphur Co., and the Freeport Sulphur Co., of Texas, and the Union Sulphur Co., of Louisiana, produced practically the entire output.

On December 23, 1924, all operations stopped at the deposit of the Union Sulphur Co., in Calcasieu Parish, La., owing to the exhaustion of the ore. The development of this deposit, which has been producing sulphur for 25 years, overthrew by cheaper production the domination of the sulphur markets by the Sicilian deposits. Exploitation of this deposit was made difficult by quicksands, but was finally, after many unsuccessful attempts, achieved by what is known as the Frasch process, devised by Herman Frasch, the founder of the Union Sulphur Co. By the adoption of this process the United States reached its present place as the leading sulphur-producing conntry of the world. The Union ore body has yielded about 10,000,000 tons of sulphur. The company expects soon to begin operations on a new large proved deposit of sulphur, called the Union Mound, about 9 miles from the town of Richmond, in Fort Bend County, Tex. It also owns another deposit in Calcasieu Parish, La., which, however, will not be worked for some time.

The agreement between the American producers and the Sicilian Sulphur Consortium, described in Mineral Resources for 1922 and 1923, has apparently aided the Sicilian producers. iPror to the World War the annual production of sulphur in Sicily averaged over 340,000 long tons. The production during and since the war has decreased materially, owing largely to the increased competition for European markets by cheaply-produced American sulphur from Louisiana and Texas mines.

In 1922 the production of sulphur in Sicily had dwindled to 135,000 long tons, but in 1923 it increased to 203,000 long tons, and in 1924 it amounted to 220,000 long tons.

From 1880 through 1903 an average annual production of 2,800 long tons of sulphur was made, starting with over 500 tons in 1880 and approximating 25,000 tons in 1903.

Imports and Exports.

The imports of "sulphur and sulphur ore" in 1924 amounted to 1,005 long tons, valued at $40,293. The exports of sulphur or brimstone from the United States in 1924 were 482,114 long tons, an increase of 9,589 tons, and with the exception of those in 1922 were the highest ever recorded. The exports of refined and sublimed sulphur and flowers of sulphur were 2,029 tons, making a total of exports of crude and refined sulphur of 484,143 tons in 1924, compared with 474,475 tons in 1923. The imports of crude sulphur increased from 87,837 long tons in 1880 to 188,990 tons in 1903, the highest recorded, and averaged 126,000 tons for the period 1880-1903. The exporting of sulphur did not begin until 1904.

NOTICES OF BOOKS.

Industrial Chemistry. In two volumes. New Edition, edited by Allen Rogers, in collaboration with a large number of authors of standing. Volume I, which deals with inorganic chemistry, consists of XX + 511 + XXIII. pp., while Volume II., organic chemistry, comprises 756 pp., and there are many illustrations. Price 52s. 6d. Constable & Company, London, Bombay, and Sydney.

The work, of which the present is the fourth edition, is one of more than passing interest to all connected with the great industry of chemistry. The work is so comprehensive, dealing clearly with so many subjects as to make the reader feel that he is getting in two volumes sufficient matter to justify half a dozen or more books. Indeed, one of the objects of the book, *vide* Preface to Volume I. is to assemble the ideas of a large number of men who are recognised authorities in their respective lines, and thus to produce a volume representative of modern American methods and processes. The work is comprehensive in its range, well produced, and cannot fail to attract a large amount of attention and approval.

The Chemistry of Rubber Manufacture. XII + 372. By LOTHAR E. WEBER, Ph.D. With several illustrations. London : Charles Griffin & Company, Ltd. Price 21s. net.

Rubber has become such an indispensable commodity in commercial affairs that an authentic work on its production and manufacture must be regarded as of great importance. The present work is based on the fifth edition of "The Chemistry of India Rubber," by Carl Otto Weber, father of the present author. The author has produced an up-to-date work, and in doing so has no doubt been imbued with a spirit of filial devotion to the gifted author of the first edition. The author has aimed, and that successfully, at placing in plain language valuable technical information at the disposal of nonscientific men interested in the rubber industry. At the same time, the scientific status of the book has not been allowed to suffer. The whole work is arranged in twelve chapters, with several indexes and illustrations.

OFFICIAL PUBLICATIONS RECEIVED.

A Shield Resistor for Voltage Transformer Testing. By Francis B. Silsby, U.S.A. Bureau of Standards.

Behaviour of Synthetic Tanning Materials Toward Hyde Resistance. By Edward Wolesenstey, U.S.A. Bureau of Standards. Price 5 cents.

Service and Regulatory Announcements. Bureau of Chemistry, Washington, D.C., U.S.A.

Durability of Cement Drain, Tile and Concrete in Alkali Soils : Fourth Progress By C. M. Williams, consulting engineer, and Irving Furlong, associate chemist, Bnreau of Standards, U.S.A. Price 20 cents.

Relations Between the Temperatures, Pressure, and Densities of Gases. U.S.A. Dept. of Commerce. Price 25 cents. (Prepared by S. F. Pickering, associate chemist.)

Architectural Acoustics. The Senior Physicist to the Bureau of Standards has prepared a useful paper on this important subject.

SPECIAL NOTICE.

THE GREAT STRIKE.

We are pleased to inform our readers that despite great difficulties, and thanks to the co-operation of a loyal staff, we have been able to publish the *Chemical News* as usual.

All direct subscribers received their copies for May 7th, and are receiving their copies as usual this week, May 14th.

Owing to the transit difficulties, and the wholesale newsagents being closed down, a great many of our readers have been unable to obtain their copies from their newsagents. We are keeping in stock ample supplies of the above issues (May 7th and May 14th) so that as soon as conditions become normal, readers can obtain their missing numbers, either direct or by ordering them through their newsagents.

Chemical News Offices,

Merton House, Salisbury Square,
London, E.C.4.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

10,559, 10,570.—Farbenindustrie Akt-Ges. —Reduction of aromatic nitro compounds. April 21st.

10,451.—Harnist, C.—Production of sulphates and sulphur. April 20th.

Specifications Published.

250,287.—Binz, Dr. A., and Rath, Dr. C.—Process for the production of heterocyclical compounds containing arsenic or antimony.

250,289.—Brutzkus, M.—Process for obtaining water gas from liquid hydrocarbons.

227,475.—Goldschmidt Akt-Ges. T.—Process of producing methyl alcohol and methylene chloride from methane.

250,380.—Howards & Sons, Ltd., & Blagden, J. W.—Manufacture of hydrogenated cinchona alkaloids.

244,708.—Henken & Cie Ges.—Manufacture of dry halogen calcium starch preparations.

245,430.—Chemische Fabrik Griesheim-Process for the production of phosphoric acid anhydride.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25 ,Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

248,593.—Barium nitrate. — Tyrer, D., Stoneleigh, West Villas, Stockton-on-Tees.

Barium compounds such as witherite are dissolved in hydrochloric acid, and to the barium chloride solution is added nitric acid to precipitate barium nitrate. The barium nitrate is separated and washed, and the mother liquo, which may be cooled to separate more barium nitrate, is used to react upon more raw material.

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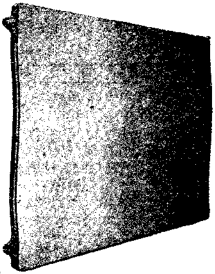

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Administrative: Central 6521.
Printing Works: Hop 2404.

THE LAW OF RELATIVE VOLUME.

By HAWKSWORTH COLLINS, B.A. (Camb.)

This law is as follows :—

The relative volume of an element is the sum of the relative volumes of its parts, any one or more of which may be zero.

The zero-volumes will be considered separately in the next paper. The demonstration of the law so far is scattered about in 26 papers published by the *Chemical News* from January, 1924, to the present time, and is naturally difficult for scientists to appreciate. It is therefore considered advisable now to place all the facts as succintly as possible before scientists (before continuing the demonstration of the structure of each element separately) in order that they may have an opportunity of seeing the certainty of the truth of the matter.

There is no hypothesis, guesswork or speculation in any part of the paper. The whole is merely an arrangement of experimental facts in such a manner as to demonstrate the truths which underlie them. The truths have been discovered, not hypothesised; for it is evidently impossible for any one to have guessed them.

Table I. is intended to be read in the following manner, taking No. 1 as an example :— The atomic weight of Sb is equal to the sum of the atomic weights of Ag and C. 21.29, 13.29 and 8.0 are relative volumes of Sb, Ag and C respectively; and the first is equal to the sum of the other two. No. 74 gives a molecule containing 21.29 (Sb), and so on.

TABLE I.

RELATIVE VOLUMES AND PART-VOLUMES OF THE ELEMENTS.

	Atomic Weights.	Vols.	Part.vols.	Refer to Nos.
(1)	119(Sb) = 107(Ag) + 12(C)	21.29	= 13.29 + 8.0	74, 75, 87.
(2)	119(Sb) = 107(Ag) + 12(C)	14.00	= 13.29 + 0.71	90, 75, 85.
(3)	119(Sb) = 107(Ag) + 12(C)	18.25	= 10.25 + 8.0	99, 101, 87.
(4)	23(Na) = 11(B) + 12(C)	23.70	= 15.70 + 8.0	76, 77, 87.
(5)	23(Na) = 11(B) + 12(C)	11.85	= 3.85 + 8.0	78, 79, 87.
(6)	51(V) = 24(Mg) + 27(Al)	17.76	= 8.71 + 9.05	80, 81, 82.
(7)	90(Zr) = 63(Cu) + 27(Al)	18.59	= 9.54 + 9.05	83, 84, 82.
(8)	90(Zr) = 63 (Cu) + 27(Al)	21.59	= 9.54 +12.05	102, 84, 103.
(9)	24(Mg) = 12(C) + 12(C)	8.71	= 8.0 + 0.71	81, 87, 85.
(10)	24(Mg) = 12(C) + 12(C)	13.69	= 8.0 + 5.69	95. 87, 96.
(11)	40(Ca) = 28(Si) + 12(C)	14.54	= 13.83 + 0.71	88, 89, 85.
(12)	40(Ca) = 28(Si) + 12(C)	12.24	= 11.53 + 0.71	93, 94, 85.
(13)	75(As) = 63(Cu) + 12(C)	12.98	= 9.54 + 3.44	91, 84, 92.
(14)	65(Zn) = 39(K) + 12(C) + 14(N)	19.59	= 18.05+0.71+0.83	104, 105, 85, 106.
(15)	52(Cr) = 24(Mg) + 28(Si)	21.73	= 8.71 + 13.02	107, 81, 108.
(16)	138(Ce) = 63(Cu) + 27(Al) + 48(Ti)	25.62	= 7.13 + 9.05 + 9.44	109, 110, 82, 111.
(17)	88(Sr) = 40(Ca) + 48(Ti)	35.1	= 25.66 + 9.44	112, 113, 111
(18)	88(Sr) = 40(Ca) + 48(Ti)	23.98	= 14.54 + 9.44	114, 88, 111.
(19)	204(Tl) = 126(Cu_2) + 78(Se)	25.57	= 2(7.13) + 11.31	115, 110, 84.
(19A)	131(Cs) = 92(Na_4) + 39(K)	69.69	=4(11.85) + 22.29	116, 87, 117.
(20)	104(Pd) = 52(Cr) + 52(Cr)	14.26	= 2(7.13)	118, 110.

All the part-volumes in Table I are shown in Table IX to be also actual volumes of the several parts when these exist as separate elements. *E.g.*, 13.29 was shown (by the intricate interdependence of several experimental facts), to be a volume of Ag, but here it is shown to be a volume of Ag when it is a part of another element.

It is necessary to notice that there are two coincidences in each one of the 21 cases of Table I. *E.g.*, in the case of Sb, its at.wt. is equal to the sum of the at.wts. of Ag and

C *at the same time* that a volume of Sb equals the sum of two volumes which are shown to be volumes of Ag and C. The probability that this would happen accidentally in one case only will now be shown to be 1 : 250,000 (at least).

Taking No. 4, Table I., as an example, because it is the first one mentioned in which the two partvolumes are each of the most general form, *i.e.*, having one figure before the decimal and two after it; the mathematical probability that, after noticing that the at.wt. 51(V) equals 24(Mg) + 27(Al), and after obtaining the exact relative volume 17.76 of V, this latter value would be capable of being split up into two parts which have been shown previously to be rel. vols. of Mg and Al, lies between

$$1 : \frac{10^6}{2} \text{ and } 1 : \frac{9^6}{2}.$$

For in order that this may be the case the figures for the part-volumes would have to appear as 871905 or 905871, *i.e.*, two particular arrangements of figures out of 531441 possible cases, where there are no zeros, or out of 1,000,000 when zeros are included; *i.e.*, one in 250,000 (at least).

This is equivalent to the statement that if there were 250,000 cases to be investigated, only one of them would *accidently* be as found; but the actual position is that 21 out of about 200 are of this nature, *i.e.*, about 1 in 10. But other considerations in Tables II-VIII., and the following paper, bring nearly the whole of the 200 into the law.

The three volumes 17.76, 8.71 and 9.05 were obtained exactly as they stand several years before this law was discovered, and each one of these volumes has been shewn to be exactly correct for several reasons in preceding papers published by the *Chemical News*.

Similar remarks apply to each one of the twenty other cases in Table I.

In Table II., Ti has the volume 5.02 fourteen times. This is a volume of Ti only *when forming part of another element.*

In Table III., Na has the volume 1.9 twenty-four times. This is a volume of Na only when forming part of another element.

In Table IV., Na has the volume 9.54 eight times, H has the volume 0.97 eight times, and H_3 the volume 1.54 six times.

In Table V., 7.49(K) occurs five times.

In Table VI., 3.04(S) occurs twice, 3.2(Si) four times, 3.74(Al) three times, and 3.91(Ca) six times.

In Table VII. 5.23(Ca) occurs twice, 3(Zr) four times, 5.02(Zr) also four times.

In Table VIII. 6.54(Na) occurs four times, 4.05(Al) three times.

Each volume here mentioned as occuring in Tables II.-VIII. is only known as such when forming part of the volume of an element, except 0.97(H).

TABLE II.

THE PART-VOLUME 5.02 OF TITANIUM.

	Atomic Weights.	Vols.		Part-vols.	Refer to Nos.
(21)	136(Ba) = 40(Ca) + 96(Ti_2)	35.7	=	25.66 + 2(5.02)	120, 113.
(22)	136(Ba) = 40(Ca) + 96(Ti_2)	24.58	=	14.54 + 2(5.02)	121, 88.
(23)	136(Ba) = 40(Ca) + 96(Ti_2)	29.00	=	14.54+9.44+5.02	127, 88, 111.
(24)	88(Sr) = 40(Ca) + 48(Ti)	30.68	=	25.66 + 5.02	122, 113,
(25)	88(Sr) = 40(Ca) + 48(Ti)	19.56	=	14.54 + 5.02	123, 88.
(26)	104(Pd) = 56(Fe) + 48(Ti)	15.10	=	10.08 + 5.02	124, 125.
(27)	128(Te) = 32(S) + 96(Ti_2)	20.55	=	10.51 + 2(5.02)	126, 74.
(28)	128(Te) = 32(S) + 96 Ti_2)	17.55	=	7.51 + 2(5.02)	129, 130.
(29)	138(Ce) = 63(Cu)+27(Al)+48(Ti)	21.2	=	7.13+9.05+5.02	128, 110,,82.

TABLE III.

THE PART-VOLUME 1.9 OF SODIUM.

	Atomic Weights.	Vols.		Part-vols.	Refer to Nos.
(30)	111(Cd) = 46(Na_2) + 65(Zn)	12.83	=	2(1.9) + 9.03	131, 133
(31)	111(Cd) = 46(Na_2) + 65(Zn)	15.56	=	2(1.9) + 11.76	132, 134.
(32)	78(Se) = 46(Na_2) + 32(S)	14.31	=	2(1.9) + 10.51	135, 74.
(32A)	78(Se) = 46(Na_2) + 32(S)	11.31	=	2(1.9) + 7.51	84, 130.
(33)	94(Cb) = 46(Na_2) + 48(Ti)	13.24	=	2(1.9) + 9.44	137, 111.
(34)	131(Cs) = 92(Na_4) + 39(K)	29.89	=	4(1.9) + 22.29	137a, 117.
(35)	199(Hg) = 92(Na_4) + 107(Ag)	17.85	=	4(1.9) + 10.25	138, 101.
(36)	199(Hg) = 92(Na_4) + 107(Ag)	20.89	=	4(1.9) + 13.29	139, 75.
(37)	115(In) = 46(Na_2) + 69(Ga)	15.65	=	2(1.9) + 11.85	140, 141.

Table IV.

The Part-Volumes 9.54(Na) and 1.54(H_3).

	Atomic Weights.	Vols.	Part-vols.	Refer to Nos.
(38)	32(S) = 23+1+3+1+3+1	15.53	= 9.54+0.97+1.54+0.97+1.54 +0.97	93, 143,
(39)	31(P) = 23+1+3+1+3	14.56	= 9.54+0.97+1.54+0.97+1.54	145, 144.
(40)	28(Si) = 23+1+3+1	13.02	= 9.54+0.97+1.54+0.97	108, 142.
(41)	27(Al) = 23+1+3	12.05	= 9.54+0.97+1.54	103, 143.
(42)	69(Ga) = 3×23 (Na_3)	28.62	= 3(9.54)	146.
(43)	23(Na) = 11(B) + 12(C)	9.54	= 3.85+5.69	79, 96.

Table V.

The Part-Volume 7.49 of Potassium.

	Atomic Weights.	Vols.	Part-vols.	Refer to Nos.
(44)	65(Zn) = 39(K) + 12(C) + 14(N)	9.03	=7.49+0.71+0.83	133, 85, 106.
(45)	65(Zn) = 39(K) + 12(C) + 14(N)	11.76	=7.49+3.44+0.83	134, 92, 106.
(46)	65(Zn) = 39(K) + 12(C) + 14(N)	14.73	=7.49+3.44+3.8	106, 92, 75.
(47)	40(Ca) = 39(K) + 1(H)	13.25	=7.49+5.76	147.
(48)	85(Rb) = 39(K) + 46(Na_2)	26.57	=7.49+2(9.54)	148

Table VI.

The Part-Volumes 3.04(S), 3.2(Si), 3.74(Al), and 3.91(Ca).

	Atomic Weights.	Vols.	Part-vols.	Refer to Nos.
(49)	59(Co) = 27(Al) + 32(S)	6.78	= 3.74 + 3.04	149.
(50)	206(Pb) = 160(Ca_4) + 46(Na_2)	19.44	= 4(3.91) + 2(1.9)	150.
(51)	55(Mn) = 28(Si) + 27(Al)	6.94	= 3.2 + 3.74	97.
(52)	107(Ag) = 12(C) + 63(Cu) + 32(S)	13.29	= 0.71+9.54+3.04	75, 85, 84.
(53)	56(Fe) = 28(Si) + 28(Si)	6.4	= 3.2 + 3. 2	151.
(54)	96(Mo) = 69(Na_3) + 27(Al)	9.44	= 3(1.9) + 3.74	152.
(55)	40(Ca) = 28(Si) + 12(C)	3.91	= 3.2 + 0.71	
(56)	182(Ta) = 94(Cb = Na_2Ti) + 40(Ca) + 48(Ti)	22.17	= (2 × 1.9 + 5.02) + 3.91 + 9.44	154, 111.
(57)	182(Ta) = 94(Cb = Na_2Ti) + 40(Ca) + 48(Ti)	17.75	= (2 × 1.9 + 5.02) +3.91 + 5.02	155.

Table VII.

The Part-Volumes 5.23(Ca), 3(Zr) and 5.02(Zr).

	Atomic Weights.	Vols.	Part-vols.	Refer to Nos.
(58)	63(Cu) = 23(Na) + 40(Ca)	7.13	= 1.9 + 5.23	110.
(59)	63(Cu) = 23(Na) + 40(Ca)	14.77	= 9.54 + 5.23	156.
(60)	209(Bi) = 90(Zr) +119(Sb)	24.29	= 3.00 + 21.29	157, 74.
(61)	118(Sn) = 90(Zr) + 28(Si)	16.02	= 3.00 + 13.02	99, 108.
(62)	118(Sn) = 90Zr) + 28(Si)	18.04	= 5.02 + 13.02	160, 108.
(63)	118(Sn) = 90(Zr + 28(Si)	16.55	= 5.02 + 11.53	161, 94.
(64)	194(Pt) = 90(Zr) + 104(Pd)	12.05	= 3.00 + 9.05	158, 144.
(65)	141(Pr) = 90(Zr) + 24(Mg) + 27(Al)	20.76	= 3.00+8.71+9.05	159, 81, 82.
(66)	141(Pr) = 90(Zr) + 24(Mg + 27(Al)	21.58	= 5.02+7.51+9.05	162, 163, 82.
(67)	138(La) = 90(Zr) + 48(Mg_2)	22.24	= 5.02 + 2(8.71)	164, 81.

TABLE VIII.

THE PART-VOLUMES 6.54(Na) AND 4.05(Al).

	Atomic Weights.	Vols.	Part-vols.	Refer to Nos.
(68)	59(Co) = 27(Al) + 32(S)	11.56	= 4.05 + 7.51	165, 130.
(69)	59(Co) = 27(Al) + 32(S)	14.56	= 4.05 + 10.51	166, 74.
(70)	39(K) = 27(Al) + 12(C)	7.49	= 4.05 + 3.44	44, 92.
(71)	85(Rb) = 46(Na_2) + 39(K)	20.57	= 2(6.54) + 7.49	167, 44.
(72)	24(Mg) = 23(Na) + 1(H)	7.51	= 6.54 + 0.97	163, 142.
(73)	27(Al) = 23(Na) + 1 + 3	9.05	= 6.54+0.97+7.54	82, 142, 38.

TABLE IX.

SUBSTANCES EMPLOYED IN TABLES I.—VIII.

	Relative Volume.	Theor. S.G. at 15°	Obs. S.G.	
(74)	Sb_2S_3 2(21.29) + 3(10.51)	4.51	4.516	Hauy
(75)	$AgNO_3$ 13.29 + 3.8 + 3(7.58)	4.26	4.253 - 4.27	Schroder
(76)	Na 23.70	0.97	0.97	Troost
(77)	B_2O_3 2(15.7) + 3(2.51)	1.800	1.803	Davy
(78)	NaCl 11.85 + 15.085	2.17	2.17	20° Kaye
(79)	SrB_6 23.98 + 6(3.85)	3.28	3.28	15° Nostrand
(80)	V_2O_5 2(17.76) + 7.53 + 4(2.51)	3.43	3.47	20° Schafarik
			3.357	18°/4 Nostr.
(81)	MgO 8.71 + 2.51	3.565	3.5699	0° Ditte
(82)	Al_2O_3 2(9.05) + 3(2.51)	3.98	3.98	14° Grandeau
(83)	Zr 18.59 (see Law of H.F.)	4.84	5.3	Nostrand
			4.15	Troost
(84)	Cu_2Se 2(9.54) + 11.31	6.71	6.71	Nordenskiold
(85)	U_2C_3 2(21.59) + 3(0.71)	11.30	11.28	18° Nostrand
(86)	UO_2 21.59 + 2(2.51)	10.15	10.15	Ebelmen
(87)	Na_2CO_3 2(11.85) + 8 + 7.53 + 2(2.51)	2.40	2.407	Favre
(88)	$CaCl_2$ 14.54 + 2(15.085)	2.48	2.480	Playfair
(89)	Si 13.83	2.025	2.004 - 2.194	Winkler
(90)	Ag_3Sb_2 3(9.78) + 2(14.0)	9.75	9.6 - 9.77	Petersen
(91)	As 12.98	5.778	5.766	Mohs
			5.884	Turner
(92)	C (diamond) 3.44	3.49	3.492	Grailich
(93)	CaS 12.24 + 15.53	2.59	2.58	Maskelyne
(94)	Si 11.53	2.43	2.48	Playfair
			2.34	Miller
(95)	Mg 13.69	1.75	1.75	Deville
(96)	SiC 7.13 + 5.69	3.12	3.12	15° Nostrand
(97)	$MnSi_2$ 6.94 + 2(7.13)	5.24	5.24	13° Nostrand
(98)	MnSi 6.94 + 7.13	5.90	5.90	15° Nostrand
(99)	Sn_2Sb 2(16.02) + 18.25	7.06	7.07	19° Bodeker
(100)	Sn 16.02	7.37	7.373	Deville
(101)	Ag_2S 2(10.25)+ 15.53	6.83	6.85	Karsten
(102)	Zr 21.59	4.17	4.15	Troost
(103)	Al_2O_3 (sapphire) 12.05 + 9.05 + 3(2.51)	3.562	3.562	Mischenbroek
(104)	$ZnCl_2$ 19.59 + 2(15.085)	2.733	2.753	13° Bodeker
(105)	K_2S. 2(18.05) + 15.53	2.130	2.130	Filhol
(160)	$ZnCl_2.2NH_3$ 14.73 + 2(15.085) + 2(0.88) + 6(5.76)	2.09	2.09	Johnsen
(107)	Cr_2Cl_6 2(21.73) + 6(15.085)	2.366	2.36	Chem. Kal.
(108)	$CaSi_2$ 12.24 + 2(13.02)	2.5	2.5	Nostrand
(109)	CeF_3 25.62 + 3(5.42)	4.7	4.7	Berzelius
(110)	Cu 7.13	8.886	8.888	Whitney

(111) Ti 9.44	5.1	5.174	20°/20 Intntl.
		4.9	Chem. Kal.
(112) Sr 35.1	2.507	2.504	Matthiessen
(113) Ca 25.66	1.56	1.566	Matthiessen
		1.55	Jobin
(114) SrO 23.98 + 2.51	3.93	3.9321	Karsten
(115) $TlVO_3$ 25.57 + 17.76 + 3(2.51)	6.0	6.019	11° Carnelley
(116) Cs 69.69	1.88	1.872 - 1.884	Setterberg
(117) KCl 22.29 + 15.085	1.994	1.994	Filhol
(118) K_2PdCl_4 2(22.29) + 14.26 + 4(15.085)	2.72	2.738	Nostrand
(119) Cr 7.13	7.3	7.3	Bunsen
(120) Ba 35.7	3.81	3.78	Nostrand
		4.00	Clarke
(121) $BaCO_3$ 24.58 + 8 + 7.53 + 2(2.51)	4.343	4.35	Kirwan
(122) Sr 30.68 (see *C.N.* 1925, CXXXI.)		4.30	Karsten
(123) SrI_2 19.56 + 2(27.75)	4.556	4.55	25°/4 Nostrand
(124) K_2PdCl_6 2(18.05) + 15.1 + 6(15.085)	2.8	2.806	Topsoe
(125) Fe_3O_4 3(10.08) + 2(2.51 + 4.45)	5.25	5.25	Gorgeu
(126) Te 20.55	6.229	6.229	40° Spring
(127) BaO 29.0 + 2.51	4.824	4.829	Playfair
(128) $Ce_4(SiO_4)_3$ 4(21.2) + 3(13.02) + 3(7.53) + 9(2.51)	4.9	4.9	Didier
(129) Sb_2Te_3 2(21.29) + 3(17.55)	6.53	6.51	13° Bodeker
(130) FeS_2 7.05 + 10.51 + 7.51	4.787	4.678	Dana
		4.882	Neumann
(131) Cd 12.83	8.655	8.655	11° Matthiess
(132) CdS 15.56 + 15.53	4.60	4.605	Karsten
(133) Zn 9.03	7.2	7.2	Roberts
(134) ZnF_2 11.76 + 2(5.42)	4.557	4.556	17° Clarke
(135) PbSe 20.45 + 14.31	8.17	8.154	Little
(136) PbTe 20.45 + 20.55	8.15	8.159	Rose
		8.06	Genth
(137) Cb 13.24	7.1	7.06	15° Nostrand
(137A) CsI 29.89 + 27.75	4.5	4.51	25°/4 Nostrand
(138) $HgNo_3.H_2O$ 17.85 + 3.8 + 3(7.53) + 14.03	4.785	4.785	Playfair
(139) Hg_2O 2(20.89) + 4.45	8.955	8.9503	Karsten
(140) In 15.65	7.35	7.362	15° Winkler
		7.31	20° Nostrand
(141) Ga 11.85	5.82	5.9	Chem. Kal.
(142) CbH 13.24 + 0.97	6.68	6 - 6.6	Nostrand
		6 - 7.37	Marignac
(143) Pd_2H 2(9.05) + 0.97	11.0	11.06	Troost
(144) Pd_3H_2 3(9.05) + 2(0.97)	10.8	10.803	Dewar
(145) P_2O_3 2(14.56) + 3(7.53)	2.13	2.135	Thorpe
(146) $GaCl_3$ 28.62 + 3(15.085)	2,376	2.36	80° Nostrand
(147) CaH_2 18.25 + 2(5.76)	1.7	1.7	Kaye
(148) RbI 26.57 + 32.77	3.57	3.567	Setterberg
(149) Co 6.78	8.702	8.71	Lampadius
		8.558	Henry
(150) PbI_2 19.44 + 2(27.75)	6.14	6.12	Rodwell
(151) Fe_3Si_2 3(6.4) + 2(7.13)	6.7	6.7	Pick
(152) Mo 9.44	10.17	10.12 - 10.32	Intl.
(153) MoC 9.44 + 3.44	8.4	8.4	20° Nostrand
(154) $TaCl_5$ 22.17 + 5(15.085)	3.68	3.68	27°/27 Intl.

(155) Ta 17.75
(156) $CuCl_2$ 14.77 + 2(15.085)
(157) $BiCl_3$ 24.29 + 3(15.085)
(158) K_2PtCl_6 2(18.05) + 12.05 + 6(15.085)
(159) PrC_2 20.76 + 2(5.69)
(160) Sn 18.04
(161) SnO_2 16.55 + 2(2.51)
(162) Pr 21.58
(163) $MgCO_3$ 7.51 + 8 + 7.53 + 2(2.51)
(164) La 22.24
(165) $CoCl_2$ 11.56 + 2(15.085)
(166) $CoCl_2.6H_2O$ 14.56 + 2(15.085) + 6(14.03)
(167) $RbNO_3$ 20.57 + 3.8 + 3(7.53)

10.25	10.08 - 10.78	Rose
3.0	3.054	Playfair
4.54	4.56	11° Nostrand
3.498	3.499	24°/4 Nostrand
5.13	5.10	Nostrand
6.54	6.53 - 6.56	Nostrand
6.954	6.952	Neumann
6.53	6.48	Baskerville
2.994	2.9 - 3.1	Chem. Kal.
6.15	6.15	Baskerville
3.115	2.987	Playfair
	3.348	25°/4 Nostrand
1.846	1.84	13° Bodeker
3.13	3.0955	17°/4 Intl.

A great many more facts in support of these values could be given, but there is no room here for more than one of each case.

Although there are five relative volumes of Na demonstrated in the nine Tables, they are in general distinct from one another as shown in the following remarks :

23.7 is the only rel. vol. of the free element.

11.85 is the only known rel. vol. of Na as a distinct element when in combination with others.

9.54 and 6.54 are the rel. vols. of Na when forming a portion of a simple element.

1.9 only occurs as the rel. vol. of Na when forming a portion of a heavier element.

The simpler and heavier elements are defined by the Fourth Main Principle in the Constitution and Structure of the Chemical Elements as follows :— *In the simpler elements H(1) forms the connecting link between the other portions 3, 7, 23, and 39. In the formation of the heavier elements the Na-portions are united to the remainder of the element without any intervening unit mass.*

(To be continued.)

THE ROYAL SOCIETY.

The Croonian Lecture was delivered by Prof. A. V. Hill, F.R.S., on Thursday, May 20, at 4.30 p.m., the subject being "The Laws of Muscular Motion."

FUNDAMENTALS IN THE CONDITIONING OF BOILER WATERS.

By R. E. Hall.

(Extract from the Proceedings of the Engineers' Society of Western Pennslyvania.)

Of the problems confronting the engineer responsible for the generation of steam, those which have their genesis in the type of water used are (1) the prevention of adherent scale formation on supply lines and evaporating surfaces; (2) the inhibition of corrosive action on the surfaces with which the water makes contact; (3) the disposal of the sludges produced in the boiler water; and (4)the delivery of dry steam of a purity such that the non-condensable gases therein will not cause trouble from corrosion when the steam condenses. And complete system of boiler-water conditioning must take cognizance of these four phases, and must realise that they are closely interrelated and require definite chemical and mechanical means for their control.

For almost four years the United States Bureau of Mines and the Hagan Corporation of Pittsburgh have been co-operating in an investigation of boiler-water conditioning. The Bureau has paid particular attention to the first two factors and the necessary chemical control in all of them, while the Hagan Corporation has devoted itself especially to the development of the mechanical features requisite for an inclusive system.

Through the co-ordination of laboratory data obtained at the Pittsburgh Experiment Station and practical operating data acquired from plants in all parts of the United

States, many basic facts have been brought to light. This paper will briefly summarise some of the fundamental features which must be emphasised in conditioning water for steam generation.

Relation of Water Softening to Boiler-Water Conditioning.

The industrial uses of water may be divided into two classes : (1) those in which the characteristics of the water itself are the thing desired; and (2) those in which its transformation into another form is the primary requisite. As examples of the former, the use of water for ordinary household or laundry, or for cooling purposes may be cited; of the latter, its use in the manufacture of artificial ice or the production of steam.

The first major distinction between water softening and boiler-water conditioning is the fact that the former deals only with the dilute water leaving the softener, whereas in the latter, attention must be focused upon the concentrated boiler water at all times. When water is to be used for ordinary household or laundry purposes, the removal of calcium, magnesium, and iron to the limit of their solubility as carbonate or hydroxide is the essential thing desired. No thought need be given to the other constituents present because the primary use is as water and not as some other modification. These uses fall strictly within the significance of water softening, for Webster's New International Dictionary defines a soft water as one "characterised by the practical absence of substances, as calcium and magnesium salts, which prevent formation of lather with soap." The criterion of efficiency in water softening is thus the extent of the removal of calcium and magnesium from a water, and the results are frequently expressed in terms of degrees of hardness as determined by the soap test.

In ice making and steam generation, however, the primary purpose of its use is not as water, but to transform it into ice or steam. Either of these uses involves the production of a pure product and the concentration of the impurities in the remaining fraction of the water. In ice making this concentration of impurities is not a matter of such great importance, because the pure primary product forms at the metal surfaces where the transfer of heat is desired and the surfaces therefore do not become contaminated by a deposition of scale. Further, the temperature range to which these surfaces are subjected is slight. In steam generation, however, the evaporating surfaces are continually in contact with the concentrated boiler water which, according to the pressure of operation, may be at a temperature of 100 to 225 degrees C. (212 to 437 degrees F.) or even higher. At these surfaces, also, the steam forms and thus favours deposition of insoluble solids upon them. It is essential, therefore, that the condition of the boiler water be controlled at all times.

Because the primary function in steam generation is changing the water into steam, thereby increasing the concentration of sodium sulphate and other salts in the unchanged water, and because the waters in different boilers are maintained at different temperatures and are continually in contact with the evaporating surface, treatment of the water for the prevention of scale deposition becomes a function of (1) the operating pressure of the boiler ,and (2) the control of the concentration of the sulphate, carbonate or phosphate, and hydroxide concentrations in the boiler water, regardless of the removal of any calcium and magnesium salts. Thus it is apparent that water softening is a much less inclusive term than boiler-water conditioning. *As a matter of fact, water softening is* related to boiler-water conditioning only because on the one hand calcium and magnesium soaps happen to be but slightly soluble, and on the other calcium bicarbonate is unstable, and calcium sulphate and presumably magnesium silicate have solubilities which decrease with temperature increase.

The second distinction between water softening and boiler-water conditioning lies in the different types of control demanded by different operating conditions.

Summary.

1. It has been shown that water softening comprises but a small part of the process of boiler-water conditioning.
2. The types of deposits that may develop from natural waters and the point in the boiler system at which they will develop have been pointed out.
3. It has been shown that the control for boilerwater conditioning must be placed on the boiler water, whatever the type of treatment used.
4. The similarity of boilerwater sludges

and steam-line deposits has been demonstrated.

5. The relation of soluble and suspended material in the boiler water to the percentage of moisture in the steam has been discussed.

6. Different methods of control of suspended material in the boiler water have been described.

7. It has been shown that a suitable control of the non-condensable gases in the steam is necessary.

BEHAVIOUR OF SYNTHETIC TANNING MATERIALS TOWARD HIDE SUBSTANCES.

By Edward Wolesensky (U.S.A. Bureau of Standards).

ABSTRACT.

A study has been made of the solvent (hydrolytic) action of syntans on hide substance during tanning, the rate of fixation of the tanning material in the hide, and the maximum which may be thus combined under various conditions of concentration and length of treatment. The solvent action on the hide varies with the individual syntan, but no relation has yet been found between this and other characteristics of the tanning material. As regards the fixation of the tanning material in the hide, the syntans may be divided into two groups, corresponding to the two general methods of preparation. Those which are obtained by first sulphonating an aromatic compound and then condensing the sulphonic acid with an aldehyde, combine with theh hide rapidly but to a very limited extent, and the combination is apparently little influenced by the concentration of the solution. The second group, in the preparation of which the order of the sulphonation and condensation with aldehyde is reversed, possesses much greater filling power, requires longer time to reach a maximum, and the time required for maximum combination is more dependent on the concentration of the solution. In the first group the combination with the hide seems to be of a chemical nature. In the second group there is evidence of both chemical reaction and some combination of a colloidal nature. High concentration of solution and long treatment are unnecessary, especially in the first group of syntans, and in many cases may actually be harmful.

SUMMARY AND CONCLUSIONS.

The various synthetic tanning materials vary very much in the extent of their solvent (hydrolytic) action on the hide substance of leather during tanning, some showing negligible hydrolysis in solutions of normal acid concentration, while others, in solutions of half this concentration, produce a practically complete destruction of the leather as such. No relation has yet been found between this behaviour and other characteristics of the syntans.

As regards the fixation of the tanning material in the hide, the syntans may be divided into two groups corresponding to thhe two general methods of preparing these products. Those which are obtained by first sulphonating an aromatic compound and then condensing the sulphonic acid with an aldehyde (designated as type A syntans) combine with the hide rapidly, but to a limited extent, and the maximum of combined tanning material, as well as the time required to reach this maximum, are but little affected by the concentration of the solution. The second group of syntans, in the preparation of which the order of sulphonation and condensation with aldehyde is reversed (type B), possesses much greater filling power, requires longer time to reach a maximum, and the time required to reach this maximum is more dependent on the concentration of the solution.

The tanning process, in the case of the type A syntans, appears to be a true chemical combination of the tanning material through its sulphonic acid groups with the hide substance, probably through amino groups of the hide protein, while in the case of the type B syntans, in addition to this chemical combination, the tanning process appears to include also some other mode of fixation, possibly adsorption.

The type A syntans are suitable only for the production of light leathers, unless used in connection with other filling materials, while the type B syntans are capable of producing a full, firm leather, such as is required for soles, without the aid of other tanning materials.

Concentrations of solutions in excess of 2 to 4 per cent. in the case of type A syntans and 4 to 6 per cent. in the case of type B syntans, as well as long periods of treatment, in excess of a week to 10 days in the case of the first group and three to four weeks in the case of the latter group, are unnecessary to attain the best results and may even be injurious.

CO-OPERATIVE FERTILISER EXPERIMENTS WITH POTATOES.

By Thomas D. Hall,

Chemist, School of Agriculture and Experiment Station, Potchefstroom.

(Department of Agriculture, Pretoria.)

This past season (1925) will be remembered by most growers as one of unprofitable potato production. The previous season was abnormally dry, and the acreage under potatoes smaller than usual, and consequently prices were firm and good. As usual, after a profitable season there was a potato boom, and the acreage under the crop was greatly increased. To complicate matters, an exceedingly cold winter made the low-veld farmers plant later than usual, while an early spring with good rains enabled the high-veld farmers to plant about one month earlier than usual. There was, consequently, an overlapping of supply that knocked the bottom out of the market very early in the season.

Effect of Early Blight.

A good deal of cloudy and rainy weather made conditions ideal for the development of early blight, and by December it was very bad around Bethal. The high veld is always well infested with this disease, but normally it develops too late to do much damage. This year conditions were favourable early in the season, and instead of being a late early blight, it was true to its name, and around Bethal must have reduced yields 25 to 35 per cent.

This was probably a blessing in disguise, as, had the potato crop developed as it promised to, it would hardly have been possible to have given the tubers away.

Early blight is a disease which is not generally recognised by farmers. On the high veld it usually develops so late in the season that many think that the leaves are drying up naturally. It can be recognised by the brown spots in which there are concentric rings. Sometimes holes form in the leaves. The early blight lives through the winter on the lands in rubbish and potato leaves and stems. It is not carried over with the seed. It can easily be controlled by spraying five times with bordeaux mixture, starting when the plants are about six inches high. There is no doubt that it will pay the individual farmer to spray. Spraying has been known to increase the yields 200 per cent. If all the farmers spray, however, there is likely to be an unprecedented glut of potatoes. The spraying benefits only the potatoes and not two or three other crops afterwards, as the fertilisers do. The chief problem at present is the disposal of the crop at a profit. Until more markets are opened up, although spraying will help a few individuals considerably, its general adoption will not be of national benefit.

The Value of Fertilisers in a Bad Year.

Notwithstanding all these unfavourable climatic and economic circumstances, the lessons to be learned from the fertiliser trials are more pronounced than ever. The main differences between the two seasons' yields can be summarised briefly in tabular form :—

	Season 1923-24	Season 1924-25.	Difference
Average of control plots	40.9	25.9	15.0
Average of complete fertiliser plots	97.8	72.2	26.5
Increase due to fertilisers	56.9	46.3	—
	Inches.	Inches.	
Percentage increase due to fertilisers	139.1	178.7	—
Rainfall	26.71	28.55	—
Number of days of rain	65	91	—

Cultural Methods.

Mr. Harry Hirschowitz and his farm manager, Mr. C. Seegal, must again get credit for the great interest they took in the experiment. The land was always in excellent tilth, and exceedingly clean and well cultivated. The fertilisers were spread in the presence of the writer in the furrows on 6 September, 1924, and Up-to-date potatoes were planted at the rate of four bags per acre on 8 September. This was almost a month earlier than the previous year. The furrows were 3½ to 4 feet apart, whereas the former year they had been only 2½ feet

apart. Approximately the same amount of seed was planted, however.

The potatoes were lifted, graded, and weighed in the presence of the writer on 19 and 20 May. The yield was less than the previous year, but the quality was good, and the tubers, to all appearance, free of disease. A few tubers were found with rhizoctonia, but this was fairly common all over the high veld this year, and even in every exhibit at the Witwatersrand Easter Show in 1925, some tubers could be found with rhizoctonia infection. There was a fair percentage of hollow heart, which is the result of too rapid a growth at some period, and a consequent disturbance of the normal physiological functions of the plant.

PLOTS USED FOR FARMERS' DEMONSTRATION.

A farmers' meeting was arranged to be held beside these experimental plots on 19 December, 1924. The day turned out rainy, and only fifteen were present. Before the demonstration was over, it began to pour, and the meeting had to be finished inside a shed. Most of those attending were farmers fully alive to the benefits of fertilisers, but desirous of knowing more about them. The writer would have liked to have shown the great differenees between the various plots of those who do not yet believe in fertilisers, but unfortunately those did not materialise. The stand was even and good, and the various treatments were marked. The whole field was badly infested by early blight.

The experiment is always there for inspection, and Mr. Hirschowitz has agreed that any farmer may visit it at any time.

The author shews in a concise and clear manner the key to treatments, shews the increase due to fertilising and shews the cost, cultivating, marketing, etc. The booklet is a useful one for farmers, pointing out the value of fertilising, of spraying against blight) and of good cultivation.

General Notes.

CALCIUM CYANAMIDE AS AN ARTIFICIAL MANURE.

The rapid increase in the use of Cyanamide has attracted a good deal of notice, and agriculturists generally will be interested to have complete and exact information as to the reasons for this quick and continuous progress.

Cyanamide is being used in almost every important agricultural country in the world, and 800,000 tons are now consumed annually. In Belgium and Germany more than 20 per cent. of the total amount of nitrogenous fertilisers used is in the form of Cyanamide, while in Italy, Cyanamide provides nearly 50 per cent. of the annual consumption of nitrogenous fertilisers. It is the cheapest nitiogenous manure, both per unit of nitrogeu and per ton.

A number of important chauges have been made in recent years in the quality, the packing, the commercial handling, and the agricultural methods of applying cyanamide.

The product, as now supplied, is oiled and therefore not dusty. It is packed in good double jute bags, made practically air and moisture proof by special treatment; it therefore stores well.

The nitrogen is guaranteed 10 per cent., with allowances for fluctuations. In addition to nitrogen, cyanamide contains lime equivalent to about 60 per cent. (calcium oxide), and for this no charge is made.

Readers interested may be glad to know that further information may be obtained from a booklet issued by Fertiliser Sales, Ltd., Adelaide House, King William Street, London, E.C.4.

POPULAR RADIO (NEW YORK).

This production assumes a new and improved form with the May issue, as the result of a sort of census of its readers. The editorial arrangements have also been transformed. The May issue contains many instructive contributions, among them, one by Sir William Bragg, K.B.E., D.Sc., etc., on "The Nature of Crystals : Ice and Snow Illustrated."

COAL.

WHAT DOES THE MINER EARN?

The Director of the Coal Industry Publications, says :—

"The ridiculous story is being spread about the country that it only costs 2s. 6d. a ton to raise coal to the pitbank. According to the last quarterly statistical summary issued by the Mines Department, the average figure is 17s. 6¾d., and this is the average figure for all classes of coal, includ-

ing slack and small coal that cannot be sold for as much as it costs to raise. Of that sum, 12s. 5¾d., a ton goes in wages. Without the subsidy the sale of that coal results in a loss of 1s. 6d. a ton.

That shows what wages are paid *per ton*. What does the miner earn *per shift*?

According to the Report of the Royal Commission, the average earnings of hewers (the real miners) vary from 12s. per shift in Northumberland (to which must be added the value of free houses and coal to householders—equivalent to 2s. per shift) to 15s. 6d. in South Yorkshire. (Many hewers, however, earn up to and over £1 per shift).

'Broadly it may be said,' continues the Report, 'that hewers' average earnings for a full week at the present minimum percentage range from £3 10s. to £4 10s. for the whole country, since six shifts are commoner than five and a half as a full week, something over the 76s. given in the table would be a fair figure.'

'The lowest adult mining wage in any of the large districts is represented by the man on subsistence at 7s. 6½d. a shift in Lancashire. There a six-day week is the rule, so that a full week's earning is 45s. The subsistence wage in Northumberland and Durham, where eleven days only are worked each fortnight, is also in the neighbourhood of 7s. 6½d., yielding a full money wage of 41s. 6d., but in these districts all married men get in addition, free coal and free houses or allowances in lieu thereof. In Yorkshire the lowest paid man gets 8s. 9d. a shift and may work six shifts a week, making 52s. 6d. In Scotland, the subsistence wage is 7s. 10½d., a shift with a proviso that the allowance added in any particular case shall not exceed 1s. 1½d.; something less than 7s. 6d. may therefore be paid in some cases. In Channock Chase, subsistence wages range from 6s. 10¼d. to 8s. 0¾d., and in most of the smaller districts they are lower, down to 6s. or thereabouts. The Lancashire figure of 45s. may be taken as fairly representing the lowest adult wage for a full week's work over any large district."

NATIONAL ACADEMY OF SCIENCES OF THE U.S.A.

The head office of the above is at Washington, D.C. It was founded in 1863, at the end of which year the number of members was 47; in 1873 the number of members was 78; in 1883, 94; in 1893, 91; in 1903, 88, in 1913, 130; in 1923, 215; and in 1925, 230. The Academy has shewn great progress in recent years, and in the last fourteen years the membership has been doubled.

SOUTH AFRICAN CHEMICAL INSTITUTE.

The report for the year ending 30th June, 1925, shews the roll of membership to consist of 91 members, 38 associates, and one student. It was resolved to petition His Majesty, the King, for a Royal Charter, giving similar privileges to the Institute to those held by the Institute of Chemistry of Great Britain and Ireland.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read at the meeting held on Thursday, February 18:—

The Spectrum of Ionised Oxygen (*OII*). By A. FOWLER, F.R.S.

The spectrum of oxygen in the region λ 6750—λ 1850 has been investigated under different conditions, and many previously unrecorded lines have been measured. In the present communication, particulars are given of about 400 lines which are attributed to the singly ionised atom (O II). The structure of this spectrum has been further elucidated, 90 lines having been assigned to the doublet system and 68 to the quartet system.

On the supposition that three of the doublet *p* terms form a Rydberg sequence, with 4R for the series constant, the value 93952 has been assigned to the term $2\ ^2p_2$, and the values of other terms have been deduced from the various combinations. The term 2*s* thus derived suggests about 240,000 for the 1*s* term, and if this represents the deepest energy level, the corresponding value for the ionisation potential will be about 30 volts, in fair accordance with the 31 volts deduced from stellar spectra. As the calculated 1*s*—2*p* lines lie in the extreme ultra-violet and have not yet been identified, this result cannot be regarded as final.

As no intercombinations between the doublets and quartets have been traced, the tabulated quartet terms depend upon an arbitrary value assigned to one of them.

So far as a comparison can at present be made, the spectra of O II and N I, as expected, show a close similarity, the wave-numbers of several of the groups of lines in O II being approximately double those of the corresponding groups of N I.

New Experiments upon the Combustion of Well-dried Carbon Monoxide and Oxygen Mixtures. Parts I and II. By WILLIAM A. BONE, D.Sc., F.R.S., F. R. WESTON, B.Sc., D.I.C., R. P. FRASER, A.R.C.S., D.I.C., AND D. M. NEWITT, Ph.D., D.I.C.

The problem of the supposed essential function of steam in the combustion of carbon monoxide is reviewed, and attacked from a new experimental standpoint. Four new lines of experimental evidence are detained, proving :—

(1) That as water vapour is progressively removed from a $2CO + O_2$ mixture, its "ignitibility" by condenser discharge sparks rapidly diminishes, the "minimum spark energy" necessary to fire it increasing, until, with a calcium chloride-dried mixture, it becomes something like twenty or thirty-fold as great as that required to fire it when saturated with moisture at a temperature of 15° C.

(2) That a $2CO + O_2$ mixture, which has been dried to an extreme degree by six months' contact with pure phosphoric anhydride, can still be ignited and exploded, provided that a spark of sufficient energy be passed through it, although the gases display a much greater "resistance" to combination that when even a minute amount of moisture is present.

(3) That P_2O_5-dried $2CO + O_2$ mixtures, which could be ignited when sparked in a given way at ordinary pressures, were easily exploded at first shot, by the same sparking device, simply by increasing the pressure up to a certain point (5 to 10 atmospheres).

(4) That the spectrum of the flame produced by the explosion of a P_2O_5-dried $2CO + O_2$ mixture at an initial pressure of 25 atmospheres, shows a continuous and diffused band spectrum, extending up to 2780 AU in the ultra-violet *without any "steam lines" being discernible.*

The conclusion is drawn that the presence of steam is not *essential* to the ignition and explosion of carbon monoxide and oxygen mixtures, and that the two gases can and do combine directly without its intervention. It is also suggested that probably the true explanation of the matter will ultimately be found in the ionisation of one (or both)of the combining gases as a necessary precedent to their combination, and that, whilst a powerful enough spark by itself can ionise and explode them, even when dried to a "Bakerian" dryness, yet the presence of even a minute quantity of steam promotes such 'ionisation," possibly by virtue of its high specific inductive capacity.

Gaseous Combustion at High Pressures. Part VI.—The Explosion of Argon- and Helium-Diluted Knall-gases. By W. A. BONE, F.R.S., D. M. HEWITT, AND D .T. A TOWNEND.

In continuance of their researches, the authors have investigated the behaviour of argon- and helium-diluted hydrogen and CO-knall-gases on explosions at various initial pressures between 10 and 150 atmospheres. The particular mixtures studied have been $2H_2 + O_2 + 6R$, $2CO + O_2 + 4R$, and $2CO + O_2 + 6R$, where $R = He$ or Ar. The results have shown that, whereas in the H_2-knall-gas series He and Ar both act as monatomic diluents only, in both of the CO-knall-gas series helium is also exercising some other influence.

Quantum Mechanics, and a Preliminary Investigation of the Hydrogen Atom. By P. A. M. DIRAC. Communicated by R. H. Fowler, F.R.S.

The quantum theory of multiply periodic systems is developed from the fundamental assumption that the dynamical variables do not satisfy the commutative law of multiplication, but satisfy instead certain quantum conditions.

The theory is applied to the hydrogen atom, and it is found to be necessary, in order to make the motion degenerate, to assume that the Hamiltonian of this system is the same function of the dynamical variables as on the classical theory when expressed in Cartesian co-ordinates, but not when expressed in polar co-ordinates.

The frequencies of the hydrogen atom are evaluated, and the Balmer formula is obtained.

NOTICES OF BOOKS.

Lectures on Certain Aspects of Biochemistry. By H. H. Dale, M.D., F.R.S. (4 Lectures); J. C. Drummond, D.Sc (4 Lectures); L. J. Henderson, A.B., M.D. (3 Lectures); and A. V. Hill, Sc.D., F.R.S. (2 Lectures). (The lectures were delivered in the University of London during the 1925 summer term). Price 12s. 6d. net. 314 pp. London: University of London Press, Ltd., 17, Warwick Square, London, E.C.4.

Lecture I deals with the control of the circulation in the capillary blood vessels. Lecture II with the active principles of the pituitary body. Lectures III. and IV. with the pancreas and insulin.

The second series deals with (1 and 2) Modern Views on the Mechanism of Biological Oxidations; (3) Certain Aspects of the Role of Phosphates in the Cell; (4) the Vitamines.

The third series includes lectures on (1) The Physico-chemical Changes in the Blood during the Respiratory Cycle; (2) The Synthetic Description of Blood as a Physico-chemical System; (3) Deductions Concerning the Circulation.

The series of two lectures by A. V. Hill deal with (1) The Physical Environment of the Living Cell; and (2) Lactic Acid as the Keystone of Muscular Activity.

The lectures are both informative and interesting, and it is well that they have been preserved in a more permanent form than in separate papers.

The "Express" Per Gross Per Dozen Reckoner.

This is Volume 21 of the series of Reckoners issued by Gall and Inglis, 31, Henrietta Street, London, W.C.2., price 2s. 6d. The *raison d'être* of the present volume is the giving at a glance the price of odd parts of a gross at so much per gross.

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The Institute of Chemistry of Great Britain and Ireland has done well to publish in pamphlet form the excellent lecture on the above interesting subject delivered before the Society on March 12, 1926, by Mr. Evan James MacGillivray, barrister-at-law. The author points out that copyright is personal property, and an infringement of it is in the nature of trespass, and hence there exists the right of action, whether damage has been caused or not. Copyright is not, however, a monopoly right in the same way as trade marks, patents and designs. As a set off the law gives protection in copyright during the life of the author and fifty years after, whereas the period of protection for patents is sixteen years and of registered designs fifteen years. Copyright does not mean literary or scientific value, and copyright can be secured for the veriest rubbish from a literary point of view.

RELATIONS BETWEEN THE TEMPERATURES, PRESSURES, AND DENSITIES OF GASES.

Mr. S. F. Pickering, Associate Chemist, U.S.A. Bureau of Standards, has prepared an interesting booklet on this subject.

The attempt has been made, in discussing the relations between the temperatures, pressures, volumes, and weights of gases, to derive the formulas in a simple manner with the minimum requirements of theoretical knowledge on the part of the reader. The experimental data involving high pressures are presented in such a form that problems of this nature can be easily solved by introducing factors taken directly from curves. The significance of the equations of state of van der Waals, of Dieterici, and of Berthelot are discussed, and the manner in which these equations may be used to predict compressibilities is explained in detail. Comparisons of the calculated values with the experimental data for various gases are shown by means of a series of curves. There is included a rather extensive bibliography of the literature pertaining to the subjects herein discussed, together with a number of tables of conversion factors and equivalents.

OFFICIAL PUBLICATIONS RECEIVED.

Elimination of Waste (Lumber) No. 16.

This is one of the useful pamphlets issued by the Bureau of Standards, Washington, and cannot fail to be useful for all engaged in the lumber trade. Price 15 cents,. Supt. of Documents, Government Printing Office, Washington.

Sand and Gravel in 1924. Price 5 cents. U.S.A. Bureau of Standards.

The output of sand and gravel in the U.S.A., in 1924, was 156,230,068 short tons valued at 97,018,115 dollars.

Antimony in 1924.
Abrasive Materials in 1924.
Gypsum in 1924.
Asbestos in 1924.
Silica in 1924.
Fuel Briquets in 1924.

The above all issue from the Bureau of Standards, Washington, D.C., price 5 cents, and will be found of service to those connected with the respective minerals dealt with.

FORTHCOMING EVENTS.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

ANNUAL MEETING AT OXFORD.

Wednesday, August 4, to Wednesday, August 11, 1926.

President—H.R.H. The Prince of Wales, K.G., D.C.L., F.R.S.

Sectional Presidents :

A (*Mathematics and Physics*)—Prof. A. Fowler, F.R.S.
B (*Chemistry*)—Prof. J. F. Thorpe, C.B.E., F.R.S.
C (*Geology*)—Prof. S. H. Reynolds.
D (*Zoology*)—Prof. J. Graham Kerr, F.R.S.
E (*Geography*)—Hon. W. Ormsby-Gore, M.P.
F (*Economic Science and Statistics*)—Sir Josiah Stamp, K.B.E.
G (*Engineering*)—Sir John Snell, G.B.E.
H (*Anthropology*)—Prof. H. J. Fleure.
I (*Physiology*) — Prof. J. B. Leathes, F.R.S.
J (*Pyschology*)—Dr. J. Drever.
K (*Botany*)—Prof. F. O. Bower, F.R.S.
L (*Educational Science*) — Sir Thomas Holland, K.C.S.I., F.R.S.
M (*Agriculture*)—Sir Daniel Hall, K.C.B., F.R.S.

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The Presidential Address, by H.R.H. The Prince of Wales, will deal (*inter alia*) with relations between scientific research, the community, and the State, both at home and in the Overseas Dominions.

Among the principal subjects expected to be dealt with in Sectional Addresses and Discussions are the following :—

The Production and Analysis of Spectra. The Scope of Organic Chemistry. Present-day Scientific Problems in Fuels. The Study of the British Lower Carboniferous Rocks. The Conception of a Species. Biology and the Training of the Citizen. The Value of Tissue Culture in Biology. The Economic Development of British Tropical Africa. Inheritance as an Economic Factor. Economic Aspects of the Financial and Labour Outlooks. Electricity Supply : Recent and Future Developments. Refrigeration. The Evolution of Human Races. Inheritance of Physical and Mental Characters in Man. Function and Design (Physiological aspects). Acclimatisation to High Altitudes. Psychological Aspects of Social Punishments. Recent Progress in Vocational Selection. Vegetative Propagation. Educational Training for Overseas Life. Educational Value of the Cinema and Broadcasting. Agricultural Education. Cultivation Methods. Dairy Problems.

The Sections will be in Session severally or jointly throughout the Meeting for the hearing of papers on many other subjects within their various departments.

Evening Receptions and Scientific Discourses, and Excursions to points of interest in the locality will be arranged. Arrangements for the accommodation of visiting Members, etc., are in the hands of a Local Committee.

ROYAL SOCIETY OF ARTS.

Monday, May 31, at 4.30 p.m. (Indian Meeting.) Lieut.-Col. Sir Arnold Talbot Wilson, K.C.I.E., C.S.I., C.M.G., D.S.O., "The Military Record and Potentialities of the Persian Empire." The lecture will be illustrated by a film showing the actual conditions of life among the military tribes of Persia. Brig.-General Sir Percy M. Sykes, K.C.I.E., C.B., C.M.G., will preside.

INSTITUTION OF MINING AND METALLURGY.

CHANGE OF DATE OF MAY MEETING.

The concluding General Meeting of the Institution of Mining and Metallurgy will be held on Thursday, May 27, 1926 instead of Thursday, May 20. The usual notice of the meeting will be issued with the *Bulletin* in due course.

ROYAL INSTITUTION.

Friday, May 28. Sir Almroth Wright, K.B.E., C.B., M.D., F.R.S., M.R.I. "Aims and Methods of Therapeutic Research."

Saturday, May 29. "Une Révolution Sociale en Egypt vers 2,000 Av. J.C. By Alexandre Moret, Professeur au Collège de France, Paris.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Specifications Published.

250,722.—Buhtz, E.—Method of and apparatus for carrying out chemical reactions.

235,548.—Mayer & Sohn, J.—Process for the recovery of chromium as chromate from chromiferous waste materials resulting from the leather industry.

250,819.—Soc. of Chemical Industry in Basle. — Manufacture of diarylamines.

250,824.—Denis, J.—Process of treating waste liquors containing cyanogen compounds.

250,883.—British Dyestuffs Corporation, Bunbury, H. M., & Robinson, R.—Mono-oxamic acids of diaminoanthraquinones.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25 ,Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

248,477.—Synthetic resins.—British Cyanides Co., Ltd., and Rossiter, E.C., 49, Queen Victoria Street, Westminster.

Thiourea-formaldehyde condensation products.—In the manufacture of resins from thiourea and formaldehyde, air or inert gas is passed through the solution of the resin during the process of concentration, which is carried out below 100° C. The air or inert gas is preferably first dried and heated. The resulting resin is neutral and free from volatile impurities.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Officia[l] Trade Marks Journal, and is Published by permission of the Controller of Hi[s] Majesty's Stationery Office.

DEZOLIN.

467,493.—Chemical substances for decolourising Cloth, Rags, and Shodd[y] Materials.—A. S. Haigh, "Elmhurst," Grange Drive, Armley Leeds. April 28th.

467,005.—Device bearing word MULTIPL[...] for manures, fertilisers, disinfectants and insect-destroying preparations.—Robinson Bros., Ltd. Phœnix Works, Ryders Green West Bromwich, Staffordshire April 28th.

466,375.—Illustration of bird pulling wor[m] out of the ground for chemical substances used for agricultural, horticultural, veterinary and sanitar[y] purposes.—C. G. Fox and [...] Stockell, 61, St. Mary Axe, Londo[n] E.C.3. April 28th.

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UNIVERSITY OF LONDON.

A Course of Three Lectures on "THE NEW ASPECT OF STRONG ELECTROLYTES" will be given (in English) by Professor Niels Bjerrum (of the University of Copenhagen) at University College, London (Gower Street, W.C.1) on Thursday, May 27th; Friday, May 28th; and Monday, May 31st, at 5.30 p.m.

At the first Lecture the Chair will be taken by Professor F. G. Donnan, C.B.E., F.R.S., Professor of Chemistry in the University.

A Syllabus may be obtained from the undersigned.

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Publisher's Announcements.

The following Books can be obtained from Rea and Inchbould, Merton House, Salisbury Square, London, E.C.4.

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All communications should be addressed to the Manager, CHEMICAL NEWS.

THE CHEMICAL NEWS,

VOL. CXXXII. No. 3450.

MERTON HOUSE, SALISBURY SQUARE,
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HIGH TEMPERATURE CARBONISATION IN 1925.

By E. V. EVANS, O.B.E., F.I.C.

(In *Fuel Economy Review.*)

Any attempt made to review the progress of high temperature carbonisation during this year resolves itself largely into an account of the recent work which has been done in connection with coke. A striking change is taking place with respect to the relative amount of attention bestowed upon the different products of high temperature carbonisation. The coke oven industry has naturally always given first thought to the solid residue, while the gas industry—concerning itself mainly with gas yields and gas quality—has neglected to a large extent the problem of the nature of the coke produced. The agitation for the abolition of the smoke nuisance, however, has brought into prominence the potentialities of coke as a domestic fuel and active interest has been displayed for some time in the possibilities of manufacturing an improved material. Moreover, the depression in the iron and steel industry, with the consequent smaller demand for oven coke, has led coke oven managers also to enquire into means whereby they may produce a desirable domestic fuel.

At the annual meeting of the Society of Chemical Industry in July, a symposium on "Smokeless Fuel" was arranged and a number of valuable papers reviewing the position at that time was presented. Drs. Lander and Fishenden summarised statistics of the consumption of coal for various purposes and indicated the vast field open to the carbonising industries should it be found possible to replace raw coal in the domestic grate by a carbonised fuel. The various known means of increasing the availability of the thermal content of coal were reviewed, and it was concluded that, for the achievement of this end, no doubt could be felt as to the desirability of the pre-treatment of all coalu sed, but that the economic aspect must in all cases be the determining factor. E. C. Evans followed by pointing out the many advantages accruing from the use of coke in preference to raw coal and deprecated the fact that the gas industry had failed to consider coal cleaning, coke quenching and grading to the extent which these important processes deserve. Slow ignition and difficult combustion were recognised as adverse properties of ordinary gas coke and it was evident that, in order to popularise this material a higher degree of reactivity than normally obtained was essential. Difficulty was experienced in defining that property of a fuel which determined its behaviour in an open grate and the various methols which been proposed for its determination were discussed. Results were given of some tests made at the Fuel Research Station on various fuels to determine their rate of reaction with carbon dioxide at a temperature of 950° C., although it was felt that co-ordination of laboratory tests with practical tests was essential before any figures obtained in the laboratory could be of more than academic interest. Much could be done to increase the activity of coke by paying attention to the composition of the ash, the blending of coals prior to carbonisation and the degree of fineness of the coal.

A COMPACT AND COMPREHENSIVE SERIES OF REACTIONS AND TABLES IN CHEMISTRY.

By ROBERT SAXON, B.Sc., F.C.S.

(*Continued from Page* 285.)

H_2O, H_2O_2, H_2S, H_2S_5, H_2Se, H_2Te, N_2H_8S : xx, $N_2H_8S_2$: xx, $N_2H_8S_4$:, $N_2H_8S_5$xx, $N_2H_8S_7$: xx.

SOLUBILITIES OF OXIDES, SULPHIDES, SELENIDES, TELLURIDES.

Li_2O : :	BeO ! ! !	B_4O_3 ! ! !	C_3O_2 ! ! !	N_2O ! ! !	O_3 ! ! !	None.
Li_2O_2 :	BeS !	B_2O_2 :	CO ! ! !	NO ! ! !	O_7S_2 hyd	FxSe hy
Li_2S : :	BeSex	B_4O_5 :	CO_2	N_2O_3	O_3S : : :	FxTe hy
Li_2Se :		B_2O_3 :	CS ! ! !	N_2O_4 hyd	O_2S : :	F_6S !
		B_2S_3 hyd	CS_2 !	N_2O_5 :	O_3S_2 hyd	
		B_2Se_3 *hyd*		N_4S_4 ! ! !	O_3Se np	
		B_2S_5xx		N_2S_5xxx	O_2Se : :	
					O_3Te ! ! !	
					O_2Te ! ! !	
					OTe	

Mg_xO hyd ?	MbxO hyd ?	Al_2O_3 ! ! !	Si_3O_2 ! ! !	P_4O hyd	S_2O_3xxx	Cl_2O :
Na_2O : : :	MgO ! ! !	Al_4O_7 ! ! !	SiO ! ! !	P_2O hyd	hyd	ClO_2 ! ! !
Na_2O_2 : :	MgO_2 ! ! ! hy	AlS hyd	SiO_2 ! ! !	P_4O_6 !	SO_2 : :	Cl_2O_7
Na O_3 hyd	MgS hyd	Al_2S_3	SiS hyd	P_2O_4 :	SO_3 : : :	xxx
Na_2S : :	MgSx ?	hyd	SiS_2 : hyd	P_2O_5 : : :	S_2O_7	Cl_4S
Na_2S_2 :		Al_2Se_3	$SiSe_2$ hyd	P_4S ?	hyd	Cl_2S_2
Na_2S_3 : hy		hyd		P_4S_3 ! ! !	S_4 ! ! !	xxx
Na_2S_4 :		AlTex		P_2S ?	S_6, S_8	Cl_2S
Na_2S_5 :		hyd		P_2S_3 hyd	S_3Se ! ! !	Cl_2S_2
Na_2S_6 :				P_4S_7 hyd	S_2Se ! ! !	Cl_4Se
Na_2Se hyd				P_4S_5 hyd	S_3Te ! ! !	Cl_2Se_3 :
Na_2Se_2 ?				P_4Se ! ! !	S_2Te ! ! !	Cl_4Te
Na_2Te :				hyd		Cl_2Te
				P_2Se hy		all hy
				P_4Se_3		
				P_2Se_3		
				P_2Se_5		
				all hyd		

KxO hy ?	CaO !	Sc_2O_3 ! ! !	TiO ! ! !	VO ! ! !	CrO as	MnO ! ! !
K_2O : : :	CaO_2 !	Sc_2S_3	Ti_3O_5 ?	V_2O_3 hy	$Cr(OH)_2$	Mn_3O_4
K_2O_2 : :	hyd	hyd	Ti_2O_3 hy	VO_2 ! ! !	hyd	! ! !
K_2O_4 : : hy	CaS		TiO_2 ! ! !	V_2O_5 !	Cr_2O_3 ! ! !	Mn_2O_3
K_2S : hy	CaS_4		TiO_3 ! ! !	V_4O_9 ! ! !	CrO_3 : : :	! ! !
K_2S_2 :	—.—.		TiS ! ! !	V_2S_2 ! ! !	Cr_2O_7 ?	MnO_2 ! ! !
K_2S_3 :	CaS_5 :		Ti_2S_3 ! ! !	V_2S_3 ! ! !	Cr_5O_9 ?	Mn_2O_7 : :
K_2S_4 :	CaSe !xx		TiS_2 ! ! !	V_2S_6 ! ! !	CrS ! ! !	hyd
K_2S_5 :					Cr_2S_2 ! ! !	MnO_4 ! ?
K_2Se :					Cr_2S_4 ! ! !	hyd
K_2Se_4 : :					CrSe ! ! !	MnS ! ! !
K_2Te :					Cr_2Se_3	Mn_3S_4
all hyd					! ! !	! ! !
						MnS_2 ! ! !
						[illegible]

Cu_4O !!!	ZnO !!!	GaO ? !!!	GeO !!	As_2O ? !!!	SeO ?	none
Cu_2 : !!	ZnO_2 !!!	Ga_2O_3 !!!	GeO_2 !	As_4O_3 / !	SeO_2 : :	Br_2S_2 hy
CuO !!!	ZnS !!!	Ga_2S_3 ?	GeS !!!	———	SeO_3 !!!	Br_2Se_2
CuO_2 !!!	ZnS_5	!!!	GeS_2 !!!	As_4O_6 :	n.p. (not	hyd
Cu_2S !!!	$ZnSe$	n.p. (not		Ist.	pure)	Br_4Te : :
CuS	$ZnTe$	pure)		cryst.	SeS !!!	Br_2Te
Cu_2S_3	all !!!			2nd.	SeS_2 !!!	hyd
Cu_2S_5				amorph.		
Cu_2Se				As_2O_4 hyd		
Cu_3Se_2				As_2O_5 : :		
$CuSe$				As_3S !!!		
$CuTe$				As_2S_2		
Cu_2Te_3				As_2S_3		
all !!!				As_2S_5		
				As_2Se		
				As_2Se_3		
				As_2Se_5		
				As_2SeS_2		
				As_2Te_2		
				As_2Te_3		
				all !!!		

Rb_2O_2 :	SrO !	Y_2O_3 hyd	Zr_2O_3 hyd	Cb_2O_2 !!!	Mo_2O_3 !!!	
Rb_2O : :	SrO_2 !	Y_4O_9 ?	ZrO_2 !!!	Cb_2O_3 !!!	MoO_2 !!!	
Rb_2O : :	SrS : hyd	Y_2S_3 !!!	ZrO_3 !!!	Cb_2O_4 !!!	Mo_2O_5 !!!	
Rb_2O_4 hyd	SrS_4 :	n.p. hyd	ZrS_2 ?	Cb_2O_5 !!!	MoO_3 !	
Rb_2S : :	SrS_5			Cb_2OS_3	MoS_2 !!!	
Rb_2S_2 :	—.—.			!!	MoS_3 !!!	
Rb_2S_4 : hyd	$SrSe$!				MoS_4 !!!	
Rb_2S_5 hyd					$MoSe_3$	
					n.p.	

Ag_4O !!!	Cd_4O hyd	InO !!!	SnO !!!	Sb_4O_6 !!!	I_2O_3 ? hyd	Te is left out.
Ag_2O !!!	CdO !!!	In_2O_3 !!!	SnO_2 !!!	Sb_2O_4	I_2O_5 : :	This is the
Ag_2O_2 !!!	CdO_2 !!!	In_7O_9 ?	hyd	Sb_2O_3	I_6S !!!	stratum of
?	CdS !!!	!!!	SnS !!!	Sb_2S_3	I_2S_2 !!!	weak affinity,
Ag_4S !!!	CdS_5 !!!	In_2S !!!	SnS_2 !!!	Sb_2S_5	$_4Se$ hyd	basic or acid.
Ag_2S !!!	$CdSe$!!!	InS !!!	$SnSe$!!!	$SbSe$	I_2Se_2 hyd	
Ag_2S_2 : hy	$CdTe$	In_2S_3 !!!	Sn_2Se_3	$SbTe$	I_4Te !!!	
Ag_2Se !!!		In_2Se_3	!!!	Sb_2Te_3	I_2Te !!!	
Ag_2Te !!!		!!!	$SnSe_2$!!!	all !!!		
		$InTe$!!!	$SnTe$!!!			

Cs_2O hyd	BaO :	La_2O_3 !!!	Ce_2O_3 !!!	
Cs_2O_2 hyd	BaO_2 !!!	La_4O_9 !!!	CeO_2 !!!	
Cs_2O_3 hyd	BaS : hyd	La_2S_3 hyd	Ce_4O_9 ? !!!	
Cs_2O_4 hyd	BaS_3 !	LaS_2 hyd	Ce_2S_3 !!!	CeS_2 !!!
all : :	BaS_4 : :	LaS_2 hyd	Ce_2Se_3 ? !!!	
Cs_2S : :	BaS_5	Pr_2O_3 !!!		
Cs_2S_2 :	—.—.	Pr_4O_7 !!!		
Cs_2S_4	$BaSe$: hyd	Pr_2S_3 !!!	PrS_2xx (easily decomposed)	
Cs_2S_5		Nd_2O_3 !!!		
		Nd_2S_3 !!!		

This is the stratum of maximum affinity for oxygen and electro-positive elements.

Sm_2O_3 !!!
Sm_4O_9 !!!
Sm_2S_3 !!!
Eu_2O_3
Gd_2O_3
Gd_2S_3
Tb_2O_3
Tb_4O_7
Dy_2O_2
Ho_2O_3
Er_2O_3
Tm_2O_3
Yb_2O_3
all !!!

The long line of aluminium "retainers," or group III is a perfect "milky way," its halide salts hydrolysing readily with water.

Below we have elements showing intense affinity for oxygen, and extreme tendency to form acid oxides.

Ta_2O_2 ?	WO !!!
Ta_2O_4	WO_2 !!!
Ta_2O_5	W_2O_5 !!!
Ta_2S_4	WO_3 !!!
all !!!	W_3O_8 !!!
	WS_2 !!!
	WS_3 !
	WSe_2 !!!
	WSe_3 !!!

Au_2O_3 !!!	Hg_2O	Tl_2O :	Pb_2O hyd	Bi_2O_2 hyd
Au_2O_2 !!!	HgO	Tl_2O_3 !!!	PbO !!!	Bi_2O_3
Au_2S :	Hg_2S	TlO_2 !!!	Pb_3O_4 !!!	Bi_2O_4
Au_2S_3 !!!	HgS	Tl_2S !!!	Pb_2O_3 !!!	Bi_4O_9 ?
Au_2Se_3 !!!	HgSe	Tl_2S_3 !!!	PbO_2 !!!	Bi_2O_5
Au_2Te_3 ?	all !!!	Tl_2S_5 !!!	PbS !!!	Bi_2S_3
!!!		Tl_2Se !!!	PbS_5 !!!	Bi_2Se_3
		Tl_2Se_3	PbSe !!!	Bi_2Te_3
		!!!	PbTe !!!	all !!!
		Tl_2Te !!!		

This stratum is the cradle of radio-activity.

Th_3O_5 ? :	UO_2
ThO_2 !!!	UO_3
Th_2O_7xx	UO_4
ThO_3 ?	U_2O_5
ThS_2 !!!	U_3O_8
	US
	U_2S_3
	US_2
	USexx
	USe_2
	U_2Se_3
	U_4Te_3
	all !!!
	UO_2S !
	UO_2Se hyd

Uranium ores are the source of Radium salts. The metal Radium finds a place in this stratum under mercury. It is more closely allied to Barium than to mercury. Note the property of giving out intense light when heated possessed by thoria, ThO_2, *especially* when mixed with one per cent. of ceria CeO_2, and the fact that cerium gives out a light when burning, richer in intensity than magnesium.

FeO !!!	CoO !!!	Ni_3O_3 !!!
Fe_3O_4 !!!	Co_2O_3 !!!	NiO !!!
Fe_2O_3 !!!	CoS !!!	Ni_3O_5 !!!
Fe_2S !!!	Co_3S_4 !!!	Ni_3O_4
Fe_2S_3 !!!	Co_2S_3 !!!	Ni_2O_3 !!!
Fe_2S_2 !!!	CoS_2 !!!	NiO_4 ?
Fe_2Se !!!	Co_4S_3 !!!	Ni_2S !!!
FeSe !!!	Co_2Se !!!	Ni_3S_2 !!!
Fe_3Se_4 !!!	So_3Se_4 !!!	NiS !!!
Fe_2Se_3 !!!	Co_2Se_3 !!!	Ni_4S_5 !!!
$FeSe_2$!!!	$CoSe_2$!!!	Ni_3S_4 !!!
FeTe !!!	CoTe !!!	Ni_2Se !!!
		Ni_3Se_4 !!!
		Ni_2Se_3 !!!
		$NiSe_2$!!!

This is the eighth group with three elements forming in each case a stratum like that which the rare earth elements really form, showing decreasing affinity for oxygen with increasing atomic weight.

The remarkable feature about this so-called group is the weak affinity shown for the haloids and comparatively greater affinity for the sulphur group.

Each series seems to be a dying away from the other groups to some other group in which there is stagnation of activity.

RuO !!!	RhO !!!	Pd_2O !!!
Ru_2O_3 !!!	Rh_2O_3 !!!	PdO !!!
RuO_2 !!!	RhO_2 !!!	PdO_2 !!!
RuO_3 !!!	RhO_3 !!!?	Pd_2S !!!
RuO_4 in	RhS !!!	PdS !!!
salts	RhS_2 !!!	PdS_2 !!!
Ru_2O_7 in salts		PdSe !!!
Rus_3 !!!		

OsO !!!	IrO !!!	PtO !!!
Os_2O_3 !!!	Ir_2O_3 !!!	Pto_1 !!!
OsO_3 :	IrO_3xx	Pto_3 !!!
OsO_4 : : byd	IrS !!!	PtS !!!
OsS_2 !	IrS_2 !!!	PtS_2 !!!
OsS_4xHOH !!!	Ir_2Se_3 !!!	$PtSe_2$!!!
		PtTe !!!
		$PtTe_2$!!!

In the above tables solubility is shown as follows :—The symbol : stands for any digit from 0 to 9, and the symbol ! for one decimal place. Thus, 3, 5, or 7, would each be represented by :, refer to as many grams of the salt soluble in 100 grams of water, and the salt be described as "soluble in water." The symbol : : has a much bigger range referring to two figures, as for example 25, 49, or 99. A salt with this after it would be described generally as "very soluble in water." Where more than 100 grams of the salt dissolve in that weight of water, we place : : : after it. If the reader thinks there is too much range between 10 and 99, he may, for his own tables place the significant figure first, followed by the :, thus, writing 8 : for 85, or eighty anything. The symbol ! means "one decimal place"; !! "two decimal places"; !!! "three decimal places," and so on. Thus, 0.00006 would be in this notation given at !!!!!, and mean anything from 0.00001 to 00009, but give an approximation near the truth, and fix itself in the mind much more readity than a row of cyphers. As a salt whose solubility is less than 0.01 gram in 100 grams of water is practically insoluble for ordinary purposes of analysis, we do not indicate solubility less than that indicated by !!! or from 0.001 part to 0.01 in 100 of water. The solubility at 18 or 20 degrees is taken. The student is recommended to make up his own tables, thus :—

Temperature	20d	40d	60d	80d
NaCl	36 : :	36.6 : :	37.3 : :	38.4 : :
NaBr	88.4 : :	104 : : :	117 : : :	118.6 : : :
NaI.2HOH	178.7 : : :	205 : : :	256.8 : : :	296 : : : @

Note @ above 65 degrees the salt splits up and the weight given at 80 degrees is

THE DIRECT OXIDATION OF MANGANOUS ION TO PERMANGANATE.

By Alan Newton Campbell.

(Abstract of a paper read before the Faraday Society, Monday, February 22, 1926.)

When electro-depositing manganese it was observed in many cases that the contents of the anode pots, a pure saturated solution of ammonium sulphate, had developed a strong pink tinge. It was thought that this must be due to traces of manganese salt diffusing into the anolyte from the catholyte (a manganous sulphate solution) and suffering oxidation to permanganate. It is known that where the anolyte is a concentrated solution of manganese sulphate or manganese chloride, oxidation to manganic sulphate or manganese tetrachloride, respectively, takes place. It was thought remarkable and worthy of investigation that when the manganese concentration is very low, this much more profound oxidation to permanganate should take place. Presumably the action should be represented

$$Mn^{++} + 4OH' + 5 + \oplus = MnO_4 + 4H^+$$

as against

$$Mn^{++} + \oplus = Mn^{+++}$$

or $$Mn^{++} + 2 \oplus = Mn^{++++}$$

in concentrated solution.

Reference to the literature showed that Sen had observed the anodic oxidation to permanganate. He gives no experimental details, nor apparently does he vary the conditions, but finds that only very small quantities of manganese salt (about 0.02 gm. of manganese sulphate in 100 c.c. of 30 per cent. acid) must be used, because if that amount is exceeded, the permanganic acid formed decomposes. He also states that manganic sulphate is produced at the same time, having a violet colour indistinguisbable by eye inspection from permanganate, but which can be detected spectroscopically. How far the results of this investigation bear out the statements of Sen will be seen in what follows, but it may be said here that not only is there an optimum concentration of manganese ion for permanganate production, but there also appears to be an optimum point for every other condition affecting the oxidation.

Rusconi electrolyses 30 per cent. sulphuric acid containing 0.05 per cent. manganese sulphate. On adding a few drops of saturated silver sulphate solution, he obtains an immediate and rapid formation of permanganate. As this paper is only available to me as an abstract, I do not know the experimental conditions. If the oxidation to permanganate were a result of the intermediate formation of persulphate, the result of Rusconi would be readily explicable as an adaptation of Marshall's reaction. At the low current densities under which the experiments described in this paper were carried out, however, there was no formation of persulphate.

Preliminary Experiments.

As the phenomenon was first observed in saturated ammonium sulphate solution, such a solution was prepared for this work. A trace of pure crystallised $MnSO_4.5H_2O$ was dissolved in this solution; to this 50 c.c. of concentrated nitric acid were added, the whole forming the anolyte. The apparatus consisted of a 500 c.c. beaker containing the anolyte and a large anode of smooth platinum foil. The catholyte of pure saturated ammonium sulphate solution was contained in a porous pot (cap. about 100 c.c.), standing in the anolyte. The use of the porous pot was an obvious precaution to prevent the reduction of the anodic oxidation product. The cathode was a platinum crucible. The solutions were first heated to boiling and then electrolysed. Nothing by hydrated manganese dioxide was obtained. Indeed, if the solution be merely luke-warm, it is sufficient to inhibit the permanganate formation, presumably because of the lowering of the anode potential.

The above experimeut was then repeated in ice-cold solution. Some permanganate was obtained, which, however, soon turned brown, depositing manganese dioxide.

It was thought that possibly this gradual decomposition of the permanganate was due to interaction between it and the concentrated acid, somewhat after the manner in which permanganate reacts with hydrogen peroxide. The experiment last described was therefore repeated, using sulphuric acid in place of nitric. The permanganate obtained was more stable, but finally also deposited manganese dioxide

on standing. It may be as well to say here that this slow decomposition of permanganate does not appear to be due to anything in the experimental conditions, for, later on, a solution was made up by dissolving crystallised potassium permanganate, etc., to have exactly the same composition as that produced by electrolysis, and this also was fonnd to deposit some manganese dioxide on standing. Indeed, it is a common observation that in a permanganate titration which has been taken beyond the end point, and the beaker left standing, decomposition takes place. The decomposition may be due to the presence of unchanged manganese sulphate and other bodies in the electrolyte.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

Papers read at the meeting held on February 18, 1926:—

Quartet Terms in the Arc Spectrum of Copper. By C. S. BEALS. Communicated by Prof. A. Fowler, F.R.S.

A series of observations of the magnetic resolutions shown by copper arc lines has led to the identification, in the spectrum of copper, of a number of quartet terms. The combinations between the quartet terms give rise to a number of multiplets, and combinations also occur between some of the quartet terms and the previously determined doublet levels.

The relations involving the inter-combination lines, as has already been pointed out by Shenstone, has made it possible to calculate the numerical values of the quartet terms, and it has been found that some of these terms must be given negative values.

The discovery of quartet terms in the arc spectrum of copper is the first instance in which the spectrum of an element occurring in the first group of the periodic table has been shown to contain terms of multiplicity higher than 2. This constitutes an exception to the rule formerly believed to be generally valid, that the maximum multiplicity of the terms in the spectrum of an element is 1 greater than the group number of the element in the periodic table. The knowledge of the existence of quartets in the copper spectrum further raises the question as to whether the previously held ideas concerning the atomic structure of copper are correct.

The Ratios of the Specific Heats of Nitrogen at Atmospheric Pressure and at Temperatures between 10° C., *and* -188° C. By J. H. BRINKWORTH. Communicated by Prof. H. L. Callendar, F.R.S.

The ratios of the specific heats are calculated from experimental measurements of the cooling effect in adiabatic expansion. The apparatus used and the details of the measurements and calculations were described in a previous communication.

It is shown that, by combining the results of experiments by Dixon, Campbell and Parker, on nitrogen at high temperatures, with Callendar's theoretical expression for the variation in the specific heats, values of these quantities at any temperature and pressure may be calculated. The agreement between the specific heat values deduced from the experimental results and those calculated in the manner indicated, is very close.

The Controlling Factors of Transfer Resistance. By E. NEWBURY. Communicated by Sir Ernest Rutherford, Pres., R.S.

The variations of transfer resistance due to condition of electrode surfaces and changes of current density have been investigated with the five metals—copper, silver, gold, nickel and platinum.

Transfer resistance is almost independent of the chemical nature of the electrode, but is high with polished surfaces and low current densities, and low at rough surfaces with high current densities.

At very high current densities transfer resistance is very low and nearly independent of the nature and condition of the electrode surface, but is greatly affected by changes of concentration of the electrolyte.

Transfer resistance is made up of two parts: (1) the resistance of a film of gas over the electrode surface, (2) the resistance of a layer of partially exhausted electrolyte surrounding the electrode.

The fall of transfer resistance at high current densities is due to the increase of conductivity of the gas film under the influence of a high potential gradient.

Overvoltage is essentially a chemical, transfer resistance a physical phenomenon.

An Investigation of Wireless Waves Arriving from the Upper Atmosphere. By R. L. Smith-Rose and R. H. Barfield. Communicated by Sir Henry Jackson, F.R.S.

This paper is a continuation of a previous communication to the Society describing experimental measurements made of the directions of both the electric and magnetic forces in wireless waves at the earth's surface. Owing to the high conductivity of the Earth, it was found to be impracticable to distinguish between waves propagated horizontally along the earth's surface, and others which might arrive in a downward direction, after deflection from the upper atmosphere. By repeating the experiments on shorter wave-lengths, these directional measurements are now shown to be successful in directly establishing the fact that, *under certain conditions, a portion of the* wireless waves arriving at a receiver comes from the upper atmosphere.

A theoretical analysis is given of the boundary conditions set up at the earth's surface for both vertically and horizontally polarised wireless waves, arriging at any angle of incidence; and a description is given of the four different sets of apparatus which have been constructed and nsed for the measurement of various quantities connected with the electric and magnetic forces under such boundary conditions. With this apparatus is has proved possible to measure the angle of incidence of the downcoming waves by three independent methods, extensions of two of which methods enable calculations of the relative intensity of the waves to be made.

Systematic experiments conducted over several months have given consistent results, in demonstrating the arrival of wireless waves at night at angles of incidence from 13° to 34°, for a wave-length of 385 m., and a range of transmission of 77 miles. Assuming the simplest case of a wave symmetrically deflected from the upper atmosphere in its passage from transmitter to receiver, the height of the deflecting layer is found to be about 8 km. Evidence was obtained during the experiments of the arrival of waves after two and three deflections from such layer.

GEOLOGICAL SOCIETY OF LONDON.

The President, Dr. F. A. Bather, M.A., F.R.S., presided over the meeting on May 5, 1926. The following paper was read :—

The Geology of the Country Between Drygarn and Abergwyesyn (Breconshire). By Kenneth Arthur Davies, M.Sc. Communicated by Prof. W. J. Pugh, O.B.E., M.A., F.G.S.

The area dealt with includes about 20 square miles of country. It is situated 5 miles north af Llanwrtyd Wells and about 3 or 4 miles south-west of the Rhayader district. The area has not previously been described in detail.

The rocks belong to the Bala and to the Valentian Series, but the latter only is described in detail. It is considered that the Valentian rocks rest conformably upon the Bala.

The sediments are generally of the mudstone-and-shale type, with subsidiary bands of grit and conglomerate. A full graptolitic succession in the Valentian rocks has been proved, from the basal zone of *Glyptograptus persculptus* to Gala Beds with *Monograptus turriculatus, M. runcinatus,* and *M. exiguus*, etc. *Cephalograptus cometa* has not been found, although it is very probable that the horizon is that of the flaggy mudstones with abundant *Petalograptus minor*, etc. In the northern part of the area, there is a conspicuous conglomerate band (the Drygarn Conglomerate) about 250 feet thick, which lies within the zone of *Monograptue atavus*.

The area lies on the western flank of the Towy Anticlinorium, but the strata are folded into a subsidiary syncline (the Gwesyn Syncline) and anticline (the Rhiwnant Anticline), with their axes parallel to that of the main structure; that is, from south-west to north-east. Faulting is practically restricted to the southern side of the Gwesyn Syncline, where for some distance an important strike-fault separates the Birkhall from the Bala rocks. The rocks are highly cleaved, the strike of the cleavage-planes being approximately parallel to the strike of the strata.

The succession is compared with those descvibed at Rhayader and Plynlimon. The conglomerates (Caban Goch) of Rhayader do not appear in this area, nor is there any indication of an unconformity at Zone, which is so characteristic a feature of the neighbouring country. The total

thickness of the Birkhill rocks is similar to that of the Rhayader country, but much greater than at Plynlimon. A noticeable feature is the greater thickness of the Birkhill rocks on the north-western, than on the south-western, side of the area.

An interesting discussion followed.

THE PHYSICAL SOCIETY OF LONDON.

Proceedings at the meeting held on Friday, March 12, 1926, at the Imperial College of Science, Prof. O. W. Richardson, M.A., D.Sc., F.R.S., President, in the chair.

The Analogy Between Ripples and Acoustical Wave Phenomena. By A. H. Davis, D.Sc., Physics Departments, The National Physical Laboratory.

The extent of the analogy between cylindrical sound waves and waves on the surface of a liquid is studied. It is established for inviscid media that as regards velocity potential the differential equations are similar provided the disturbance is small and is harmonic in type. It is then shown that the velocity potential in a field of inviscid surface waves may be used to represent that in a field of cylindrical sound waves, provided the size of any obstacle bears the correct relation to the wavelength of the disturbance. In the case of a liquid having a depth greater than half the wavelength, it further follows that the height of a surface wave is a measure of the condensation of air in the corresponding acoustical condition.

The effect of moderate viscosity is of the same type for sound waves and for surface waves; it is most marked for short wavelengths, and it decreases amplitudes without appreciably altering the wavelength. The decrease in amplitude depends upon the viscosity, and upon the time which has elapsed since the commencement of free oscillations, or, for maintained oscillations, since the disturbance concerned left the source. For surface waves further damping occurs if the depth is less than half a wavelength, and the apparent viscosity may be appreciably increased by contamination of the surface by means of a film of oil of excessive thinness. Viscous effects are generally negligible in the case of sound, but they are appreciable for the water waves that would usualy be used in a small ripple tank not greater than, say, 10 ft. in size. Mercury waves are much less affected by viscous damping than water waves.

Experiments conducted with model obstacles in a ripple tank showed that the effects of the meniscus around the obstacle and of the amplitude of the source are not important. When the water becomes stale on exposure—and presumably contaminated—the relative distribution of ripples around obstacles is appreciably modified, but not to an extent which would correspond to any very marked change in the loudness of a sound.

Experiments have also been conducted, outside the limits of strict mathematical analogy, using an impulsive disturbance instead of a maintained train of waves. When it is recognised that a sound pulse travels out singly, whereas with ripples subsidiary wavelets accompany the main pulse, the correspondence between ripple photographs and sound pulse photographs is most striking.

Illustrations are given of the use of a ripple tank in connection with architectural acoustics, and of its general value where wave phenomena are concerned.

Demonstration.

The author, assisted by Mr. Berry, illustrated the paper with a demonstration in which (*a*) continuously emitted ripples were viewed stroboscopically under conditions illustrating refraction and also diffraction by a grating, round a screen, and through apertures of various sizes; and (*b*) single pulses, internally reflected within a wooden enclosure, representing the vertical section of an auditorium and laid in the ripple tank, were viewed by instantaneous illumination.

Discussion.

Major W. S. Tucker said that the author had described an elegant method for solving practical acoustic questions which it would be difficult or impossible to handle mathematically. In the neighbourhood of aerodromes great inconvenience was caused by the noise made by the running up of engines before flight. The author had attacked this problem, at Major Tucker's request, by means of a model illustrating the screening due to a hangar, the wavelength employed being produced to scale, and the ratios of the intensities at various points in the shadow being estimated as described in the paper. The speaker exhibited some of the photographs obtained in this connection. It must be borne in mind, however, that the two-dimensional solutions given by the paper do not neces-

sarily give safe guidance in the case of three-dimensional problems. The speaker illustrated this point by a further slide, showing by polar diagrams the calculated distribution of intensity in the neighbourhood of a sound source screened by placing it (*a*) midway between two parallel plates and (*b*) inside a tube of diameter equal to the distance between the plates, so that the two systems are identical in section. In this extreme case two entirely different sound distributions are obtained.

Dr. J. H. Vincent congratulated the author on his learned and delightful paper. He would have thought that, for all purposes except refraction experiments, a reflecting surface like that of mercury would have been preferable to the water surface actually used. The meniscus effect at the edges of a screen can in a mercury tank be eliminated by making the screen of thin cover glass and allowing it to float on the mercury. For refraction effects mercury is unsuitable, however, because on account of the cost of mercury the dimensions of the apparatus have to be small, and the reduction of depth necessary to exhibit refraction effects cannot be achieved because of the tendency of mercury to gather into drops of a certain minimum depth on a surface which it does not wet. Amalgamated submerged surfaces have therefore to be used as screens, and their position cannot conveniently be photographed.

Mr. E. G. Richardson said that the impulse method seemed to him more satisfactory than the ripple method for studying the accoustics of buildings, and it had, he believed, been more extensively used by Sabine for that purpose. In filming plays in which wrecks occur it used to be the practice to photograph a sinking model boat, but usually no attention was paid to the scale of the ripples, with the result that the waves seen were sometimes longer than the boat. The method of scaling adopted by the author would have been useful in such cases, but it appeared to be the practice, under the financial conditions which now obtain in America, to sink full-size vessels.

THE CHEMICAL SOCIETY.

Thursday, May 20.

The Temperature Effects on Mixing Liquids. By W. M. Madgin, H. V. A. Briscoe, and J. B. Peel.

The temperature changes which accompany the formation of binary non-aqueous liquid mixtures have been investigated in the case of 626 possible mixtures from 37 different liquids taken in equal volumes. These temperature changes are usually quite appreciable and sometimes considerable.

Experiments on the influence of variations in initial temperatures, on the change of temperature accompanying mixing, indicate that the latter is more negative the higher the initial temperature. Experiments on the result of diluting mixtures with one of the constituents afford evidence that the constituent liquids contribute unequally to the observed temperature change.

A study of the effects of previous dilution of one or both of the constituents of a binary mixture with a third liquid gives strong evidence that compounds or complexes of the types indicated below exist in mixtures and that those of the AB type sometimes persist on dilution either with one of the components, or with a third liquid.

All these results appear to be consistent with the hypothesis that the condition in a binary mixture is represented by the following scheme of equilibria :—

$$A_x \rightleftarrows xA$$

$$B_y \rightleftarrows yB$$

$$\uparrow\downarrow$$

$$zA_nB_m$$

Consideration of the dielectric constants in relation to the observed temperature changes seems to show that these quantities are unrelated.

The Alcohols of the Hydro-aromatic and Terpene Series. Part V. The Geometrical and Optical Isomerism of the Methylcyclohexanols. By G. R. C. Gough H. Hunter, and J. Kenyon.

Both hexahydro-*o*-cresol and hexahydro-*m*-cresol should exist in two geometrically isomeric forms each capable of resolution into optical antipodes, and hexahydro-*p*-cresol should exist in two geometrically isomeric forms incapable of such resolution. These substances have now been prepared, and evidence of their chemical purity is given.

The two geometrically isomeric methyl-

*cyclo*hexanols derived from each cresol are found to possess widely differing viscosities and the relation between the magnitude or the viscosities of the complete series of six inactive methly*cyclo*hexanols and their acetic esters, is found to be in agreement with the views of Thole.

It has been found possible to effect the geometrical interconversion of the *cis*- and *trans*-methly*cyclo*hexanols through the medium of the *p*-toluenesulphonic esters. Partly by this method and partly by the oxidation of the alcohols to methyl*cyclo*-mexanols have been determined. Two distinct types of relationship are observed.

A study is also made of the effect of experimental conditions on the proportions of the two geometrical isomerides formed by various methods of reduction.

An account was given of the stage reached in the investigation of the higher peroxides of hydrogen by the President, Mrs. Baker, and Miss Carlton.

FORTHCOMING EVENTS.

THE ROYAL SOCIETY.

Papers to be read on Thursday, June 3, 1926, at 4.30 p.m.—

A. E. H. Tutton, F.R.S. "The Alkali Perchlorates and a New Principle Concerning the Measurement of Space-Lattice Cells."

T. E. Stanton, F.R.S. "On the Flow of Gases at High Speeds."

G. I. Taylor, F.R.S., and W. S. Farran. "The Distortion of Crystals of Aluminium Under Compression. Part I."

E. V. Appleton, R. A. Watson Watt, and J. F. Hord. "On the Nature of Atmospherics. II." Communicated by Sir Henry Jackson, F.R.S.

ROYAL INSTITUTION.

Tuesdays, June 1, 8.—I. "Shah Abbas of Persia, the Contemporary of Queen Elizabeth." II. "Chinese Turkestan and the Pamirs." By Brigadier-General Sir Percy Sykes, K.C.I.E., C.B., C.M.G.

Thursdays, June 3, 10.—I. "Iron in Antiquity." II. "Science in Antiquity." By J. Newton Friend D.Sc., Ph.D., F.I.C., Municipal Technical School, Birmingham.

To receive and discuss the following papers :—

"Opal Glass." By J. W. Ryde. A communication from the Research Laboratories of the General Electric Co., Ltd. Wembley.

"The Electrical Conductivity of Glass at High Temperatures." By F. F. S. Bryson, M.A., BSc., F.Inst. P.

"The Influence of Moisture on the Rate of Melting and on the Properties of Soda-Lime-Silica Glasses." By Edith M. Firth, B.Sc., F. W. Hodkin, B.Sc., Michael Parkin, M.Sc., and Prof. W. E. S. Turner.

"The Physical Properties of Zinc Oxde Containing Glasses." By S. English, D.Sc., and Prof. W. E. S. Turner.

EIGHTH ANNUAL DINNER.

The eighth annual dinner of the Society will be held in the Hotel Cecil, Strand, London, W.C.2., on Tuesday, June 1, 1926, at 7.0 for 7.15 p.m. Tickets (excluding wines) 12s. 6d. each. Evening dress.

The guests from America are expected to number about 30 and it has been suggested as a happy arrangement that each visitor should have a host at the dinner.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, W.C.

Wireless Section Meeting.—Wednesday, June 2, 1926, at 6 p.m. (Light refreshments at 5.30 p.m.) "Low Frequency Intervalve Transformers." By P. W. Willans, M.A.

ROYAL SOCIETY OF ARTS.

John Street, Adelphi, London, W.C.2.

Indian Section.—Monday, May 31, 1926, at 4.30 p.m. "The Military Record and Potentialities of the Persian Empire." By Lieut.-Col. Sir Arnold Talbot Wilson, K.C.I.E., C.S.I., C.M.G., D.S.O. Brig.-General Sir Percy M. Sykes, K.C.I.E., C.B., C.M.G., will preside.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

An additional meeting of the Society will be held on Wednesday, June 2, at the Chemical Society's Rooms, Burlington House, Piccadilly, W.1., at 8 p.m., when Mr. Alfred Lucas, O.B.E., F.I.C., will read a paper on "Problems in Connection with Ancient Egyptian Materials."

SOCIETY OF GLASS TECHNOLOGY.

Ordinary General Meeting, June 1 and 2. First Session to be held in the University College, Gower Street, London, W.C.1., on Tuesday, June 1, 1926, at 2.30 p.m.

Second Session to be held in the Library of the Research Laboratories of the General Electric Co., Ltd., Wembley, on Wednesday, June 2, at 2.15 p.m.

CORRESPONDENCE.

THE ASSOCIATION OF NUMBERS IN CHEMISTRY.

The association of two or more atomic weights in numbers is frequently met with in the course of calculation of numerical relationships of the elements, and in other calculations which involve the use of atomic weights. No satisfactory method, however, appears to be known for systematically working out numerical associations of atomic weights. The writer considers his original method, described in this letter, as a perfectly satisfactory one for the purpose of working out by proportion numbers, which are formed by the association of atomic weights with atomic ordinals or with other whole number atomic weights.

I.

The number 64784 is the principal commencing number. It is actually the sum of 64546 - 00238. From it, numbers are derived by proportion with 3546/A, where A is an atomic weight. To the product, 00238 is added, and the number is reduced to five figures. Unity may be added in the first place, when it is necessary. (It is also usual to add unity beyond the fifth place, when accurate relationship is required, but this is not dealt with here.) The number obtained is multiplied by (*a*) 238/A; (*b*) 2377/A, where 238 is the three-figure approximate of 2377. The product is usually the association of atomic ordinal with the vertically adjacent atomic weight in the periodic system. The success of this process largely depends on the two original numbers. In this case they appear to be well chosen.

Examples—

(1) 64784/5897 × 3546 + 10238 = 49194
K Rb
49194/5897 × 238 = 1985445

(2) 64784/7992 × 3546 + 10238 = 38982
Na K
38982/7992 × 238 = 1160875 = 11 + (1 · 39125)

(3) 74784/5897 × 3546 + 10238 = 55207
55207/5897 × 238 = 2228127 = (14 + 8) + Si

In the first instance, when the multiplier is 2377 the product is 1982943. This number is the association of the atomic weight of Kr adjacent to Rb in the periodic system, with the atomic ordinal less one long period plus one element.

In the other two instances, 1159412 = 11 + 1 - 2 × 20294 2225318, 2377 = 25318^2/Al (26965).

Other instances of this type of numerical relationship—

Substituting As for Co in (2),
49194/7496 × 238 = 1561923
49194/7496 × 2377 = 1559953
Then 61923 = As, 59953 = Ge 7257525.

Fe for Co. by 238 gives 2096639; by 2377 gives 2094093. 94093 Rb, Sr 964926 = 96639 - 001464, and is exact for another relationship. 64546 + 16 × 238 = 749268; proceeding as before with 3546/7496, 208763 is the final product, i.e., 38 - 18 + the atomic weight Sr. In most cases where the numerical relationship is not obvious, it is quite ready to follow.

II.

In the more detailed development of the same method, it is possible to work with the numbers as they are calculated, instead of approximating to five places, adding the three figure equivalent, and then the unity in the latter places of the number.

The following examples are typical —

491941/5897 × 2377 = 1982947.

The association may also be read directly.

The atomic number should be subtracted from the fiual part of the number

82928/391/91941 = 2306828

Na Rb
which may be read as 23, 93172.

Logarithms figure prominently in this position of the working.

1436093 and 1736093 (36093 = 14.008 + 12.005 + 10.08)
64784/1736093 × 3546 + 10238 = 2347024
2347024/1736093 × 2377 =5687423
87267/13281/47024 = 1398938 Y. associated with the ordinal.

64784/1436093 × 4517057 = 2036436 (4517057 = 1 -5482943)
2036436/1436093 × 238 = 3374934
2036436/1436093 × 2377006 = 3370688
70655/725/36436 = 26746945.

The atomic ordinal 26 associated with the logarithm of 5584.

ALEXANDER SAKOSCHANSKY, B.Sc.

26, Castle Boulevard,
Nottingham.

HYDRO-CARBON ATOMIZER.

(*Pulverisateur d'hydrocarbures.*)

(Filed at the Canadian Patent Office— No. 260,147.)

Alexander Ivanovitch Kousnetzoff, London, England, 27April, 1926. Filed 20 June, 1924. Serial No. 293,064.

Claim.—1. A process for atomising heavy hydro-carbons consisting in directing the hydro-carbon jet against a body of suitable shape, this body penetrating into the central portion of the stream of fluid and dividing it into a number of thin streams which pass in a zig-zag path through a number of passages after which a whirling movement is imparted thereto, so as to obtain a completely atomised and homogeneous mixture, substantially as described.

2. Apparatus for atomising heavy hydro-carbons consisting in the combination of a venturi diffuser with a hollow body of suitable shape, adapted to serve as a deflector for the injected fuel, the hollow body being provided on its periphery with passages which terminate in bell-shaped ports provided at the upper end of the hollow body so as to impart a whirling movement to the atomised fluid passing from the passages, substantially as described.

CHEMICAL SOCIETY FELLOWSHIP.

At the end of 1925 the Fellowship Membership reached 4,083, an increase of 120 over the figures at the end of 1925. Sir William A. Tilden and Mr. William E. Bicker Dike have been Fellows for sixty years, and during the year, fourteen Fellows attained their jubilee in membership. The assets of the Society at the end of the year amounted to £30,092 3s. 2d.

BULLETINS PUBLISHED BY THE SOUTH AFRICAN DEPARTMENT OF AGRICULTURE.

A Biometrical Analysis of Merino Wools. By PROFESSOR J. E. DUERDEN, M.Sc., Ph.D., and V. BOSMAN, B.Sc.

Some Factors Influencing the Keeping Quality of Butter. By D. J. RETIEF, M.Sc.

Co-operative Fertilizer Experiments With Potatoes. By THOMAS D. HALL, Chemist, School of Agriculture and Experiment Station, Potchefstroom.

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THE CHEMICAL NEWS,
VOL. CXXXII. No. 3451.
MERTON HOUSE, SALISBURY SQUARE,
LONDON, E.C.4.
TELEPHONES:
Administrative: Central 6521.
Printing Works: Hop 2404.

THE GREEN COLOUR OF TUNGSTEN OXIDE.

By J. A. M. VAN LIEMPT.

Some time ago the *Chemical News* containeda report[1] from N. H. Smith and H. Lukens dealing with the colour of WO_3. In this article it appears as if my earlier results[2] would be contradictory to some of theirs, and I must reiterate once more positively that my conclusions take into account only the green-yellow colour that WO_3 adopts at *ordinary temperatures*, whereas their investigations deal with the deep green colour arising on ignition.

The transition, yellow to greenish-yellow, occurring at ordinary temperatures is caused, as I demonstrated clearly, by reduction with organic substances under the influence of light. The depth of the colour depends only on the grain size of the WO_3 so that the intensity increases as the grain size decreases.

This is easily proved by preparing WO_3 in the colloidal state. Starting, *e.g.*, with a 0.5 *N* Na_2WO_4 solution and adding an equal volume of 0.5 *N* HCL together with an equal volume of alcohol or an equal volume of 0.5 mol solution of glucose, these solutions after exposure for some hours to the light of a 1,000-watt lamp become deep blue[3].

Also the photograph of a glass plate greased with yellow WO_3, part of which was protected from the influence of light by tinfoil, shows clearly the change in colour.

The *green colour is a transition* colour between the pure yellow WO_3 and the blue of W_2O_5, traces of W_2O_5 being sufficient to produce a green colour.

This appears most clearly from the test of Langmuir[4] with atomic hydrogen. If we fill a gas bulb, containing a tungsten wire, with hydrogen of about 2 cm. of mercury pressure, the yellow WO_3 present in the lower part of the bulb will adopt a green colour, even after a current passage of a few seconds, this colour becoming deeper and bluer if the current flows for a longer time.

It is therefore to be expected, that on ignition of WO_3, any circumstance that causes a slight reduction, is followed by the appearance of a green colour, *e.g.*, reducing burner gases[5] and also alkali salts.

Now it is remarkable that among the latter, sodium is the most active, after which rank lithium, rubidium and potassium. This is apparent from tests starting with pure WO_3, prepared by precipitation of ammonium tungstate with HCl, the said WO_3 remaining yellow after ignition. By addition to this WO_3, the chlorides of the above-mentioned alkali metals in varying quantities and ignition in air in an electric furnace to a temperature of 900° C., the change in colour could be observed.

According to the intensity of the colour the different samples were divided into four groups:—

	% NaCl	% LiCl	% RbCl	% KCl
Deep green ...	0.1 or more	1 or more	—	—
Pale green ...	0.07 or more	0.2 or more	—	—
Greenish yellow	0.03 or more	0.07 or more	0.2 or more	0.5 or more
Yellow ...	0.01 or less	0.03 or more	0.1 or less	0.2 or less

By taking instead of NaCl: $NaNO_3$, $NaClO_4$, $NaClO_3$, Na_2O_2, NaOH, Na_2CO_3, or Na_2WO_4, no difference is observed, neither on ignition in a current of oxygen.

By boiling the deep green WO_3 with strong alkali, a blue residue remains, which on ignition rapidly becomes greenish-yellow.

Eindhoven, Holland.

[1] *Chem. News*, 1926, CXXXII., 33.
[2] *Z. Anorg. Chem.*, 1921, CXIX., 310.
[3] Compare Wassiljewa-Sainsowa, *Journ. chim. de l'Ukraine*, 1925, I., 425, and Benrath, *Zeitschr. wiss. phot.*, 1917, XVI., 253.
[4] *J. Amer. Chem. Soc.*, 1914, XXXVI., 1708.
[5] Compare Heyne, *Z. f. techn. Phys.*, 1925, 292.

ON THE SEPARATION OF GERMANIUM.

By Isaburo Wada and Sechi Kato.

(Extract from Scientific Paper of the Institute of Chemical Physical Research, Tokyo.)

Introduction.

The aim of the present investigation is to find some suitable method of separation of germanium with the view to incorporating it in the general scheme of qualitative analysis which enables us to separate all the metallic elements hitherto recognised from any substance without allowing any of them to escape detection.

General Discussion.

1. It has been stated in a previous report that among the various methods of converting any substance of unkown constituents into its solution as a first step to its exact qualitative analysis, the most convenient method would be to proceed by treating the finely pulverised sample first with nitric acid, evaporating the solution to dryness, and when the sample is not an alloy, the residue insoluble in nitric acid being evaporated to dryness with nitric acid after heating it my hydrofluoric acid, and uniting these residues and heating them to 120° for an hourfi and again treating it by nitric acid, separating from the part rendered insoluble by dehydration, thus obtaining the first solution; then treating the insoluble part by hydrofluoric acid to obtain the second solution, and the still remaining residue being treated step by step with several reagents. Germanium, being similar to tin, titanium, columbium, arsenic, etc., in its behavious towards the reagents, can be consdered to enter at least partly into the first solution and completely into the second solution above described, which is proved to be so by experiments. (Experiments 1, 2, 3, 4.)

2. Since tin, titanium, zirconium, columbium, tantalum, arsenic, antimony, molybdenum, tungsten, and selenium can also enter into the second solution described above, it would be most convenient, from a point of view of separating a rarer element usually present in a very small quantity, to precipitate off at this point arsenic, antimony, molybdenum and selenium as much as possible by hydrogen sulphide and from its filtrate to separate off completely columbium, tantalum, titanium and zirconium, leaving germanium completely in solution with as small quantities of the other elements as possible. Experiments have shown that 99.5 mg. of arsenic out of 100 mg., 98 mg. of antimony out of 100 mg., 40 mg. out of molybdenum out of 50 m., and 48 mg. of selenium out of 50 mg., can be precipitated by passing hydrogen sulphide into the second solution under the same conditions. Another experiment has shown that 50 mg. of each of titanium, zirconium, columbium and tantalum are precipitated completely by making the filtrate from the precipitate produced by hydrogen sulphide alkaline with ammonia, after hydrofluoric acid has been evaporated off, and by heating about 5 c.c. of the solution with 15 c.c. of 6 N. ammonium sulphide solution in a pressure bottle at a temperature of boiling water, and that the small quantities of arsenic, antimony, molybdenum and selenium which have not been precipitated by hydrogen sulphide, and various quantities of tin, germanium and tungsten which have been present in the original solution remain completely in the solution by that treatment. Thus, the treatment of the second solution first with hydrogen sulphide, then with ammonium sulphide has been proved to be suited to precipitate off most of the other elements at the first step for the separation of germanium. (Experiments 5 and 6).

3. Although germanic bromide is known to be hydrolysed by water, it might be kept undecomposed in a solution of hydrobromic acid charged with bromine ,and since this compound volatilizes readily at room temperatures, these considerations suggested that germanium might be separated as bromide. To make sure that this was the case, a few experiments were made on the metal, the oxide and the sulphide of germanium, and on the residue obtained by evaporating the ammonium sulphide solution containing germanium, by heating them in a distilling flask with a concentrated solution of hydrobromic acid charged with bromine ,collecting the distillate in cold water. The same experiment was made also on the other metallic elements, which may be present in the ammonium sulphide solution after titanium, zirconium, columbium and tantalum were precipitated off as mentioned in the last paragraph. These experiments have shown that germanium, arsenic and selen-

ium are completely transferred to the distillate and all the other elements remain completely in the residual solution, thus making the separation of germanium together with the other two elements from the rest of the elements present in the same solution quite possible. This distillation method was adopted. (Experiments 7, 8, 9, 10 and 11.)

4. The first solution described in the foregoing paragraph (1) may contain a large number of elements, and it was almost certain that any of them except germanium, arsenic and selenium would not be distilled as bromide but be left behind when the solution was evaporated and the residue was heated in a distilling flask with a concentrated solution of hydrobromic acid charged with bromine. A few experiments were made with some common and rarer elements, and they have shown that this was exactly the case, so that the separation of germanium, arsenic and selenium from all the other elements in the first solution can be effected also by this distillation method. (Experiment 10.)

5. The fact that germanium present in the residue which has been obtained by evaporating a nitric acid or an ammonium sulphide solution was perfectly separated by distilling as bromide suggested that this element in any solid sample might be separated completely by heating that sample with hydrobromic acid in the same way as described above. It was found in fact by direct experiments ,however, that 50 mg. of germanium in the form of precipitated wet sulphide was distilled completely as bromide, and that the same element in a commercial germanium oxide (Kahlbaum) or in a pure dry oxide was not distilled completely when the sample was pulverised and heated in a distilling flask with 10 c.c. of hydrobromic acid (sp. gr. 1.49) charged with bromine until 2-3 c.c. of the solution remained in the flask. As these results were far from satisfactory, a plan of separating germanium and the other two elements as bromides by distilling directly the original sample at the beginning of the analytical process was not adopted. (Experiment 12.)

6. The distillate described in the preceding paragraphs (3) and (4) may contain arsenic and selenium besides germanium, and always contains hydrobromic acid and free bromine. As it was proved by experiments that selenium is precipitated completely from this distillate, by passing sulphur dioxide and adding a small quantity of potassium iodide, after free bromine has been removed by means of air current, a plan of separating selenium at this point, leaving germanium and arsenic in the solution was adopted.

7. It is a well-known fact that potassium germaniflouride is obtained in characteristic crystals and the formation of this compound was utilised for the extraction of germanium. Our experiments have shown that under a certain condition even only 0.2 mg. of germanium is detected, and 0.9 mg. out of 1 mg. of the same element is readily precipitated as this compound when it is present alone, while arsenic is not precipitated at all under the same condition even when 100 mg. of it are present alone. These facts snggested that germanium in the filtrate from the precipitate of selenium described in the last paragraph might be separated from arsenic. Incidentally it has been found that the formation of this crystalline compound is much hindered by sulphuric acid present in the filtrate just mentioned, and at least a few milligrams of the element are prevented from precipitating, unless the acid has been removed before the addition of the precipitants. Experiments 15, 16, 17, 18 and 19.)

8. Although germanium was proved to be precipitated completely as K_2GeF_6 out of the filtrate described above when sulphuric acid in the solution has previously been removed, still the presence of a small quantity of germanium, which has been separated from arsenic by this precipitation method, was hardly to be confirmed by converting it into a characteristic white compound of germanic sulphide, owing to the fact that arsenic in the solution is with difficulty removed completely from the precipitate of K_2GeF_6 and that on passing hydrogen sulphide into the hydrochloric acid solution of this precipitate the sulphide of arsenic appears together with that of germanium, making the characteristic colour of the latter invisible. This method of separation, therefore, was not adopted.

9. For the separation of germanium from arsenic several analytical methods have been employed. Of these the most suitable seemed to be the distillation of germanium as chloride in the presence of

strong hydrochloric acid by oxidising arsenic to the less volatile pentachloride by means of chlorine. Our experiments made with this distillation method have shown that under the conditions of Procedure 6 even 0.5 mg. of germanium, which was present with 100 mg. of arsenic in the filtrate from the precipitated selenium *described in the preceding paragraph* (6), is completely separated, and another experiment has shown that under the conditions of Procedure 7 even only 0.1 mg. of the same element in the distillate can be detected and separated as a characteristic white precipitate of germanic sulphide. This distillation method was, therefore, adopted.

10. To see to what degree of perfection the above described methods of separation work, several kinds of mixtures containing permanium and various other elements in varying proportions were prepared, and subjected to analysis using those methods. The results were found to be fairly satisfactory.

EXPERIMENTS.

1. Treatment of commercial germanium oxide with nitric acid.—144.1 mg. of a dry germanium oxide (Kahlbaum), which was pulverised to fine powder, were taken in a casserole and digested with 10 c.c. of HNO_3 (1.20) on a steam bath for 15 minutes. The mixture was stirred with 20 c.c. of *hot water and filtered repeatedly* through the same filter until a clear filtrate was obtained. The insoluble residue was determined to be 58.8 mg. as oxide. This was digested with 5 c.c. of 48% HF, and a clear solution was obtained. The solution was evaporated with conc. HNO_3 and evaporated again. The residue was heated in an air bath at 120° for 1 hour, and then digested with HNO_3 (1.20) on a steam bath for 10 minutes. The mixture was stirred with 20 c.c. hot water. A clear solution was not obtained, but about 5 mg. of a dark brown residue remained undissolved. The mixture was filtered.

The clear solution, which was obtained from the original substance by the first treatment with HNO_3 1.20) as mentioned above, was evaporated to dryness, and the residue was heated in an air bath at 120° for 1 hour. The dehydrated residue was treated with HNO_3 (1.20) and with hot water exactly in the same way as in the previous case. Complete solution did not result, and the mixture was filtered. The filtrate was united with that obtained above, and evaporated to dryness. The residue was almost white after it was ignited, weighing 131.8 mg. The two residues, which remained after the final treatment with HNO_3 (1.20) described above, were united and ignited, a dark brown substance, which weighed 13.5 mg., being obtained.

2. Treatment of purified germanium oxide with nitric acid.—50 mg. of germanium oxide, which was purified by the method described in Experiment 27, were treated exactly in the same way as in Experiment 1. There remained a white residue insoluble in HNO_3 (1.20) in the final treatment with that acid, weighing about 10 mg., after ignition, which dissolved completely in H.F.

3. Treatment of precipitated germanic sulphide with nitric acid.—Germanic sulphide, which was made by passing H_2S into the solution of distilled germanium chloride containing about 50 mg. of Ge, was treated exactly in the same way as in the previous experiments. The sulphide dissolved completely by the first treatment with HNO_3 (1.20), but the residue, which was obtained from this solution by evaporating it to dryness, and dehydrating that product, did not dissolve completely by the final treatment with HNO_3 (1.20), about 5 mg. of Ge being present in the insoluble *residue, which dissolved completely in* H.F.

4. Treatment of metallic germanium (Kahlbaum) were ground to fine powder and digested with HNO_3 (1.20) as described in Experiment 1. The metal presently disappeared attended by a vigorous reaction, but what was obtained was not a perfectly clear solution even after the addition of hot water. The solution with some insoluble matter in it was evaporated to dryness, and the residue was dehydrated by heating as in the previous experiments. This residue did not dissolve completely in HNO_3 (1.20), and the insoluble part, which was determined to contain about 5 mg. of Ge, dissolved perfectly in HF.

5. Treatment of the hydrofluoric acid solution with hydrogen sulphide.—10 c.c. 40% hydrofluoric acid solutions were prepared containing separately several quantities of various elements, which may be present in " the hydrofluoric acid solution " of the residue insoluble in HNO_3 Each solution was diluted with the same

volume of water, saturated with H_2S, and the resulting precipitate was filtered off. (In the case where the filtrate was dark-coloured, 1 c.c. conc. H_2SO^4 was added to it and the solution was saturated with H_2S, the resulting precipitate being filtered off.) The filtrate was warmed, then saturated with H_2S, and the resulting precipitate was filtered off.

General Notes.

SUFFOLK IRON FOUNDRY (1920) LIMITED.

The British Oxygen Company have been appointed agents for the brands of welding rods, "Ferro-silicon," "Super-silicon," and "Sifbronze," of the above company, The agency covers Great Britain and Ireland, India, Australia and New Zealand.

WHOLESALE PRICES IN APRIL.

BOARD OF TRADE INDEX NUMBER.

The Board of Trade index number of wholesale prices in April shows a fall of a half of one per cen. compared with the figure for March, the indices for the two months being 86.4 and 86.8 respectively, taking the average of prices in 1924 as 100. The average for food rose by 1.3 per cent., and that for industrial materials fell by 1.3 per cent. in the later month compared with the corresponding averages for March. The widest movements in the group averages were in cereals, for which a rise of 3.5 per cent. was recorded, and in textile materials other than cotton, which fell by 3.4 per cent. In each of the remaining six groups of commodities the April average was within two per cent. of the March figure.

COAL.

During the month of April, 1,106,200 men were employed in the British coal trade (colliers), and the amount of coal produced was 19,598,700 tons. The total subvention paid by the Government amounted to £20,510,392. Since, the weekly output averaged about 5,300,000 tons.

NEW BOLIVIAN BANK LAW.

In future, foreign banks and their branches will have to pay a tax of 10 per cent. of their net profits.

COMMERCIAL TRAVELLERS IN GUATEMALA.

Commercial travellers will have to pay a tax of £5 4s. for six months.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

Thursday, May 20, 1926.

Synopsis of the Croonian Lecture. By PROF. A. V. HILL, F.R.S.

1. *A common principle in all vital motion.*—In all kinds of contractile tissues there are certain similar, or analogous, processes; so that in discussing properties of striated muscle we are really dealing with very general phenomena.

2. *Methods of investigating muscle.*—General description of methods available.

3. *Chemical studies of muscle.*—Discussion of recent work on chemical reactions of breakdown and recovery, and rôle of glycogen, lactic acid and phosphate.

4. *Myothermic studies of muscle.*—Splitting up of the individual response into separate phases, contraction, relaxation, recovery, "Time-scale" of muscle.

5. *Effect of doing work on energy exchanges.*—Governor-mechanism in Muscle (Fenn)? Effects of shortening ,or lengthening, on heat production (Wyman.) Possible utilisation of potential energy of active muscle for recovery.

6. "*Viscous-elastic*" *phenomena in muscle.*—If physiological response of muscle undergoing stretch be less than that of muscle allowed to shorten, why is tension at any given length so much greater during stretch than during shortening? Answer provides important clue to nature of contractile process. Maximum work of muscles, in relation to speed of shortening. Re-development of contraction after quick release. "Viscous-elastic" model. Hypothesis (Garner) that activity in muscle is accompanied by formation of new molecular pattern, either in surfaces or throughout the fibre. Hysteresis in "packing" of molecules on surfaces.

7. *Certain applications to man.*—"Viscous-elastic" phenomena in human muscular movement.

SOCIETY OF PUBLIC ANALYSTS

AND OTHER ANALYTICAL CHEMISTS.

An ordinary meeting of the Society was held at theh Chemical Society's Rooms, Burlington House, on Tuesday, May 18, Mr. E. Richards Bolton, President, being in the chair.

Certificates were read for the first time in favour of Messrs. Francis Harrold Banfield, M.Sc., Ph.D., A.I.C., and Albert Lester Williams, A.I.C.

Certificates were read for the second time in favour of Messrs. Arthur Barraclough B.Sc., A.I.C., George Gordon Elkington, Kenneth Massy Griffin, M.Sc., A.I.C., Herbert Firth,, A.I.C., and Thomas Pickerill, B.Sc.

The following were elected Members of the Society—Messrs. John Allen, Michael Thomas Casey, B.Sc., M.Sc., George Henry Davis, Julius Grant, M.Sc., A.I.C., and Miss Monica Mary Ruston, F.I.C.

The following papers were read and discussed :—

The Detection and Determination of Glycerin in Tobacco. By A. CHASTON CHAPMAN, F.R.S., F.I.C.

The tobacco is mixed with sodium sulphate (to absorb moisture) and extracted with acetone. The residue from the extract is freed from resins, and its glycerol content determined by a modification of Zeisel's silver iodide method. For a qualitative test the glycerin is separated by extraction and distillation, and identified by (1) the acrolein test; (2) formation of dihydroxyacetone; and (3) formation of glycorol-α-uaphthylurethane.

The Crystalline Bromides of Linseed and Some Other Oils. By HAROLD TOMS, M.Sc., A.I.C.

It is shown that the most insoluble bromide of linseed oil, as crystallised from ethyl acetate, is not an ethyl ester, but a glyceride. When hydrolysed with hydrobromic acid it yields, as its only recognisable product, hexabromostearic acid, but this does not prove the absence of tetrabromostearic acid, which is converted by hydrobromic acid into a sticky derivative. The insoluble bromides of perilla, candlenut and Para rubber seeed oils have also been prepared, and found to be identical with the linseed oil bromide. Tetralin is a better solvent than ethyl acetate for crystallising oil bromides.

The Polarimetric Determination of Sucrose in Condensed Milk. By A. BLAKE AND PAULA HENEGGER.

The authors describe a modification of the method of Revis and Payne, in which mercuric nitrate is used both as precipitant and as inverting agent. Results agreeing with the gravimetric results were obtained in the winter months, but there was a discrepancy in summer due to such causes as altered period of lactation, period of fresh grass feed, etc., on the original milk. To prevent this, the quantities were made up to definite weight after dilution, instead of being diluted to a known volume.

The Separation of Iridium from Iron. By W. R. SCHOELLER, Ph.D.

An outline is given of some of the proposed methods of separation, and it is shown why they have not been found suitable in analytical practice. The author favours a method based on the precipitation of ammonium chloroiridate $(NH_4)_2IrCl_6$, and allowance is made for the amount of iron adsorbed by the ammonium chloride precipitate.

The Determination of Very Small Quantities of Iron. By H. L. SMITH, B.Sc, F.I.C., AND J. H. COOKE, M.C., B.A., A.I.C.

A colorimetric method has been devised in which the sensitiveness of the thiocyanate reaction is very greatly increased, and directions are given for obtaining all the reagents free from iron. Zinc interferes, and for determining iron in zinc compounds the iron thiocyanate is extracted with a suitable solvent, such as a mixture of amyl alcohol and ether, and the colour of the extract matched.

The Determination of Total Alkaloids, Sugar and Oily Substances in Opium. By J. N. RAKSHIT.

In the method described both the alkaloids in an aqueous extract of opium and those remaining in admixture with the opium wax are determined. For the determination of sugar, titration with Fehling's solution after removal of alkaloids gives fairly concordant results. Added oil or wax is indicated by a saponification value differing from that of opium wax, and is approximately determined by the appearance of the opium when heated on a plate over steam.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Electricity in Mines: A Short Survey. By R. NELSON, Member.

SUMMARY.

The paper provides a general review of the present position of electricity in mines, with particular reference to coal mines. Dealing with the safety aspect, it is claimed that the special requirements of colliery work have been amply met by manufacturers of electrical apparatus. It is further claimed that Great Britain has established a lead over other countries in respect of the design of mining electric plant. The question of public versus private supply is discussed, and the author states that, in his opinion, supply from an outside source is overwhelmingly correct policy wherever two rival estimates show an equal, or nearly equal, financial result.

Some general statistics are given and the conclusion is ultimately drawn that one-half the motive power of the mines of Great Britain still remains non-electric.

Finally, some important directions in which the use of electricity in mines is likely to increase, are mentioned.

The annual report with statistical appendixes issued by the Secretary for Mines forms a very good indication of the extent and importance of the mining industry. The statistics show, by the number of persons employed and the value of the output, that in Great Britain coal mining is of much greater importance than metal mining.

This survey will be mainly concerned with the use of electricity in coal mines.

The general position of electrical engineering in relation to mining is worth a few moments' consideration. Mining was already an old industry with fixed traditions and well-established practices long before electricity made its appearance. In order to obtain due consideration, electrical engineers had therefore to overcome the natural tendency to follow old and well-tried methods, as against the adoption of a new, untried, and even "mysterious" agent. It is chiefly for this reason that although the special adaptability of electricity for use in connection with mining was mentioned in a paper before the Institution of Mechanical Engineers as early as the year 1852, it was not until 1883 that the first electric motor was seet to work below ground in a British mine. This was at the Trafalgar Colliery, Drybrook, Gloucestershire, and the person responsible was the late Sir Francis Brain. Electrical and mining engineers had, however, still to do a good deal by way of educating each other and themselves, before they evolved practical and satisfactory solutions of all the problems presented by the distribution and use of electricity under mining conditions. There are now more than 1½ million horse-power of electric motors in use in and about the mines of Great Britain, whilst it is doubtful whether there was as much as 10,000 horse-power in 1900.

The relative importance of the coal-mining and metal-mining industries, and the extent to which electricity is at present being utilised in mines, may be guaged by the information given below, which has been abstracted from Mines Department records:

Coal Mines.—The total amount of coal raised in Great Britain in 1924 was 267,061,027 tons, and the number of persons employed 1,213,724.

The total number of coal mines at work in 1924 was 2,855(of which 1,629 were wholly or partly electrically equipped. It follows that 1,226 mines, probably most of them small mines, were still at the end of 1924 without any electrical equipment.

The horse-power of motors installed in and about coal mines at the end of 1924 is given below:

Surface	671,036 h.p.
Underground ...	810,896 h.p.
Total	1,481,932 h.p.

An analysis of the motive power employed above and below ground shows the following:—

	h.p.
Winding	107,139
Haulage	411,816
Pumping	348,803
Ventilation	102,911
Coal Cleaning	112,660
Coal cutting	92,121
Miscellaneous uses	306,482
Total ...	1,481,932

Taken over the last ten years the average rate of increase per annum of the horse-

power of electric motors installed below ground has been 6.83 per cent. The actual percentage increase of the total number of motors installed below ground at the end of 1924 over the total number installed below ground at the end of 1915 is 73 per cent.

Metalliferous Mines.—With reference to the amount of metalliferous ore raised in Great Britain in 1924, the following are the principal items: Iron ore 11,050,589 tons; lead ore 14,294 tons; tin ore 3,546 tons; manganese ore 2,457 tons; zinc ore 2,317 tons. The number of persons employed in metal mining was 19,481.

The total horse-power of motors installed in and about metalliferous mines at the end of 1924 was 23,524. Of this total, 11,753 h.p. is installed on the surface and 11,761 h.p. underground. The chief uses are for pumping (9,391 h.p.) and ore-dressing (2,806 h.p.) The Mines Department records show that the horse-power of electric motors installed above and below ground in metal mines has increased by 17 per cent. in 5 years.

The tables do not of course give any indication whatever of the total amount of power of all kinds installed in and about the mines, and there is no definite information available from which an up-to-date estimate can be made. The last census of production of the United Kingdom published in 1912 refers to data collected during the year 1907. It was then estimated that the total horse-power of engines in mines and quarries amounted to 2,495,134. It is certain that the horse-power utilised in quarries is comparatively small, and it is, the author thinks, fair to assume that the power utilised in coal mines cannot now be much, if any, less than 3 million h.p. If that total is anywhere near to being correct, it follows from data already given that about one-half the engine capacity in the mines of Great Britain still remains non-electric.

The increase of electrical horse-power in each year is made up of (*a*) conversions from other forms of motive power and (*b*) additional motors. It is probable that the newly installed horse-power due to the former still greatly exceeds the newly installed horse-power due to the latter, and important conversions will continue to be made, for there are coal mines which continue to distribute compressed air from the surface, and more which remain reluctant to carry current beyond thhe shaft bottom. These decisions may be wise in a few cases, but it is difficult to believe that they are justified in every case that exists.

The above is the main direction in which electrical engineers may look for further extension in the use of electricity in mines. Other important directions are (1) the greater use of in-bye machinery in place of hand-putting and pit ponies, (2) the extended use of coal-face machinery, and (3) the extended use of electric safety lamps.

As to (1), the number of pit ponies is steadily, if slowly, decreasing, but in 1924 there were still more than 65,000 employed below ground in British mines. It is reasonable to expect, and to hope for, an accelerated rate of decrease in this number and the gradual establishment of a complete system of mechanical haulage, wherever possible, from the coal face to the shaft.

With regard to (2), there are few places where the increased use of machinery is more desirable than at the working face. The coal-face worker's task is the most severe, and statistics show it to be the most dangerous of all underground occupations; he therefore needs all the relief that improved conditions of working and efficient mechanical appliances can offer. On the other hand, it may be pointed out that the growth in the use of coal-cutting and coal-conveying machinery in British mines from year to year is disappointingly small. The question involved is one upon which it would be rather ont-of-place for an electrical engineer to hold too decided an opinion, but with less than 20 per cent. of the coal output machine-cut, it may reasonably be asked whether an accelerated rate of increase in the number of coal-cutting machines employed, if practicable, would not be one unobjectionable method of increasing the output per employee, the gradual shrinkage of which in most of the coal-fields is one of the present difficulties of the coal-mining industry.

On the subject of (3), no survey would be complete without reference to the continuous and rapid progress which has been made during the last ten or fifteen years in the use of electric safety lamps. In the year 1912 there were only 10,727 electric lamps in use, but progress is best indicated by a short table compiled from the Mines Department records :—

Year		No. of electric lamps in use		No. of oil safety lamps in use.
1912	...	10,727	...	697,664
1916	...	126,784	...	610,821
1920	...	245,900	...	635,127
1924	...	356,817	...	576,318

Miners' electric lamps as now used give not less than 1 candle-power at the end of 9 hours' use. They are fitted into a 2-volt acid or a 2.5-volt alkaline battery, and weigh about 6 lb. More light can of course be obtained, but only at the expense of added bulk and weight, and it has always been a debatable point whether the advantage of additional light is worth the handicap of added weight. Larger and heavier lamps giving more light are, however, beginning to come into use for hewers and others able to hang up their lamps while they are at work. It is unlikely that the electric hand-lamp will displace the oil safety-lamp entirely, but it seems clear that the number of electric lamps will soon exceed the number of oil lamps in use.

In conclusion the author would refer briefly to two further directions in which electrical enterprise and research may hope to be of added assistance. The first is the prospect held out by Prof. W. M. Thornton's experiments of a great improvement in the matter of undergronnd illnmination from the ordinary power distribution system, with due and proper regard to all the requirements of safety. The details were explained by Prof. Thornton in his paper. The second has reference to storage-battery locomotives for underground use. This development may well prove to be a very important contribution towards the solution of the pit-pony problem. Electrical engineering is in fact building up the reputation of an ever-ready help to the mining industry. The steam engine in its early days was often referred to as " the right arm of mining operations." It may not unreasonably be claimed that the position once held by the steam engine is now, in 1926, firmly occupied by electricity.

THE ADMINISTRATION OF INDUSTRIAL RESEARCH.

(*Extract from the Report by* Edward R. Weidlein, *Director of the Mellon Institute of Industrial Research, Pittsburgh, Pa.*)

The general absence of scientific research methods in chemical technology led to the formulation in 1906 of the Industrial Fellowship System of Mellon Institute. This system has not only aided in successfully arousing the interest of American manufacturers in research, but has appealed to their imagination and their intellect, with the result that to-day the research department is the rule rather than the exception in industrial organisations. Although the Industrial Fellowship System remained experimental for nine years, since 1915 it has been in a strong position financially as well as administratively. This gradual development has brought the directional methodology of the Institute to the stage that appears sound, and certain results of this experience are believed to be of general interest.

The philosophy of scientific research is that no one can succeed in laboratory experimentation without benefiting his fellowmen. If a scientist is productive in his investigations, his work must result for the good of humanity. If a research laboratory is founded, it is because there is a need for it, and it will bring public benefit. Every kind of scientific research establishment is administered to meet a public want. The character of virtue is best seen in the life of a scientist devoted to the service of research.

Our many research institutions and industrial research laboratories have endowed opportunity. They have created individual responsibility. They have aroused individual ambitions to the highest efforts. It follows, then, that these research establishments must have much in common in basic directional principles. It follows, too, that the exchange of managerial experience in research is for the social good.

Prior to establishing an industrial research laboratory in their organisation, the company executives should believe in the realisable possibilities of research, should intend to give it proper financial and moral support, and should know what to expect from it, should have determined whether to try a comprehensive and thorough type of research or to limit the work to a narrower study of specific problems as they arise, and should be prepared to give sufficient time to put the laboratory well on a sound basis. The laboratory director, if properly chosen—and great care is needed in selecting him—can be relied upon to do the rest, but he should be aided in launching the work correctly, and in maintaining suitable facilities and staff for attending to all scientific research of the company.

An industrial research laboratory is often an experiment and hence it is usually prudent to start in a small way and gradually build on acquired experience. Every plant laboratory must justify itself and develop into an essential industrial service bureau. Work should generally begin in a simple and relatively inexpensive building, planned so as to permit of easy extension as the activities require and as the appropriation allows.

The scope of the research, like several other features, should be determined as time goes on. At the outset there will be several problems awaiting investigation that will supply plenty of work for the small group of scientists. Gradually it will become the habit for various department heads to pass problems over to the laborator director. Every company that establishes a research laboratory should be educated in the value of and need for more and more scientific investigation. There, a good motto for an industrial research director is "*Make our laboratory necessary.*" All who have benefited by the results of scientific research should feel it a duty to do something for the acquisition of additional knowledge.

Industrial history makes it clear that happy ideas and chance discoveries have not contributed materially to the progress of technology. The stimulus for development generally results from demand, and in manufactures organised on modern lines the working out of new processes and the improvement of existing processes consist mainly in the application of scientific fact and theory, the raw material of the applied scientist and engineer. Industry, therefore, should sustain pure ah well as technical research, not merely for altruistic reasons, but because pure science research makes for progress in technology. The successful director of industrial research is a Janus with two faces, one of which receives the impressions from technology, while the other is turned toward the laboratories of pure science.

OXIDATION OF SODIUM SULPHITE.

By Ralph B. Mason and J. H. Matthews.

(*Abstracted from The Journal of Physical Chemistry.*)

1. The rate of oxidation of an aqueous sodium sulphite solution is highly dependent on the rate at which oxygen is bubbled through the solution. The shape and size of the bubble greatly influence the rate of oxidation.

2. Pure oxygen and ozone greatly increase the rate of reaction both in the dark and in the light. The rate of the light reaction is more than doubled when the flow of air is increased from 30 to 60 liters per hour.

3. Hydroquinone and phenol in .001 N solutions act as positive catalysts to the light reaction while sugar, quinine sulphate rubber, and copper sulphate, act as negative catalysts to the light reaction.

4. Our experience with contamination due to some constituent of rubber re emphasises the necessity for the exercise of the utmost care in the exclusion of all possible contaminations in the study of photochemical effects.

5. There is no apparent relationship between the light absorption of the catalysts and their action upon the photochemical oxidation of sodium sulphite.

ENGINEERING AND RESEARCH.

By Milo S. Ketchum.

Dean, College of Engineering and Director Engineering Experiment Station, University of Illinois.

(*Abstract from the Bulletin of the School of Mines and Metallurgy, University of Missouri.*)

Engineering is both an art and a science. The art of engineering is much older than the science of engineering. Many engineering works of great magnitude were constructed by the ancient peoples. Great irrigation works constructed in India, Chaldea, and Egypt made it possible for relatively high state of civilisation to exist in these countries at least four thousand years before the Christian era. The Egyptians constructed great tombs known as the Pyramids and other monumental works. The Romans constructed large masonry aqueducts to bring drinking water into the cities, and also constructed a magnificent system of hard roads.

The ancient engineering works were constructed by man power without the use of adequate tools. It is recorded by Herodotus that it required the labour of 100,000 men working for more than 20 years to build the Great Pyramid. Most of the laborers on these great engineering wor

were slaves that did their work under the lash of the taskmaster. With man power only, the amount of labor available was limited, and large engineering structures in ancient days could only be constructed by the rulers with forced labor.

With the invention of power we have a new era, which may be called the industrial age. The industrial had its beginning in the invention of the steam engine by Watt in 1765. The steam engine was followed by the invention of the steam boat by Fulton in 1807. The first railroad was built in England in 1830, while the first railroad in the United States was built in 1831. These great inventions were followed by the invention of the telegraph, the telephone, the electric motor, the electric generator, and, in our own time, by the invention of the aeroplane and the wireless.

In constructing engineering works the ancient peoples were limited to the use of masonry, timber, brick and iron. Iron made by the puddling process was high in cost and limited in amount. The invention of Portland Cement early in the nineteenth century made available a new building material by means of which masonry structures could be built with the expenditure of much less man power than was required in the construction of stone masonry. The invention of the Bessemer process for making structural steel made it possible to produce a substitute for iron greater in strength and cheaper in first cost. The invention of Bessemer steel led to the greatly increased use of steel in the building of bridges, tall buildings, and other industrial structures.

The ancients knew very little of the science of engineering as we now know it. It was necessary to design and build structures by the "cut-and-try" method. An interesting example of this cut-and-try method was the construction of the Pont-y-Prydd bridge built in Wales by Edwards in about 1750. This bold masonry arch was built three times before a structure was secured that was finally successful.

The science of engineering depends both upon pure science and applied science, and therefore there could be relatively little progress in this direction until the sciences of mathematics, physics, chemistry, geology, mechanics, applied mechanics, and a knowledge of the properties of engineering materials were placed upon a substantial foundation. The first mathematician to consider the nature of the resistance of solids to rupture was Galileo in 1638. Galileo treated solids as inelastic, not being in possession of any facts as to the properties of engineering materials. He endeavoured to obtain the strength of a beam, one end of which was built into a wall and which was loaded to the breaking point either with its own weight or with an applied load, and he concluded that the beam tends to turn about an axis perpendicular to its own length, and in the plane of the wall. This is known as Galileo's Problem.

The two most important landmarks in the development of the problem proposed by Galileo were the discovery of Hooke's Law in 1660 and the equations of Navier in 1821. Hooke's Law of the proportionality of stress to strain provided the necessary experimental foundation for the theory of elasticity, and the general equations of Navier made possible the calculation of small strains in elastic bodies. Much work was done by Saint Venant and other scientists, but it remained for Rankine in 1858 to put the theory of the strength of materials on a practical scientific basis. When Rankine was appointed to the chair of Civil Engineering at the University of Glasgow in 1855, he found a chair without a science. In a few years Rankine developed the theory of applied mechanics and the theory of thermo-dynamics, and wrote books on civil engineering, applied mechanics, steam engines, and machinery, that were used as textbooks until recently, and are still standard reference books.

Rankine found engineering a trade and made it a science. In addition to a vigourous mind, Rankine had a thorough training in mathematics, physics and the sciences, and an extensive experience as an engineer.

It may be interesting to know that the first systematic calculation of the stresses in bridge trusses was given in a book published by Squire Whipple at Utica, New York, in 1847, and that the next book on the design of bridges was published by Herman Haupt in Philadelphia in 1851. The first systematic calculation of stresses in structures by algebraic and graphic methods was given in the first volume of "Graphic Statics," written by Culman and published in Germany in 1861.

In the beginning of engineering schools, the curriculum consisted mainly of languages, mathematics, chemistry and physics,

together with surveying and brief courses in engineering construction. Engineering teachers were for the most part men with little or no engineering experience, and as a result the training in the engineering school did not prove to be of any material benefit aside from the liberal arts training. The engineering graduate was not looked on with favour, either by the financial man who employed him, or the practical engineer under whom he worked. There was a constant conflict between engineering theory and engineering practiee.

With the advance in pure and applied science, the curriculum of the engineering school has changed from an inferior liberal arts course with a smattering of engineering practice, to a course in applied science with a close and intimate contact with the latest advances in engineering practice. Engineering schools now have fully equipped laboratories in which commercial tests are mode of materials and machines. Many engineering teachers have made notable additions to scientific knowledge as applied to engineering construction. The feeling of antagonism between practical engineering and theoretical engineering has disappeared, and engineers and technical schools are now working in very close cooperation. Engineering contractors find that they must needs keep in touch with the laborotory if they are to solve present-day construction problems. The most approved and latest advances in mechanics together with properties of materials are now recognised as essential to engineering construction.

Engineering is a profession of progress, and engineering research is the foundation of engineering progress. In the earlier days of industrial development it was possible for the individual inventor or scientist to accomplish results while working alone. With the increased size and complexity of modern industry ,it is now no longer possible to carry on many of the investigations without organised effort. Engineering research may be classified according to whether it is undertaken by (1) individual manufacturers, (2) associations of manufacturers, (3) commercial laboratories, (4) Government laboratories, (5) scientific societies, or (6) universities and colleges.

The development of engineering research by manufacturers has usually gone through the following stages of development: (1) research applied to the elimination of manufacturing troubles; (2) research having some new and specified commercial object; (3) researches for the purpose of establishing standards; (4) researches in pure science with no specific commercial application in view; (5) research applied to public service.

NOTICES OF BOOKS.

CHEMISTRY IN AGRICULTURE.

We have been advised that the Chemical Foundation Incorporated, of Beaver Street, New York City, have just succeeded in sending to the press " the first authoritative book that ever covered in popular language the very vital part played by chemistry in the advancement of agriculture, and the whole problem of food production."

" Chemistry in Agriculture," is the title of the work. The publishers state that " twenty of the foremost authorities on agricultural chemistry have collaborated on " Chemistry in Agriculture " to tell their stories of what the chemistry of the soil, the plant, the animal, and of the human body itself means in furnishing the food that must sustain your life. In giving the last word on all the fascinating problems of the farmer, these authorities have built a book that is of intense interest to everyone who must necessarily be concerned in the matter of food values, production and supply. Chapters concerning vitamins, nitrogen, nutrition, cereals, sugar, fruit and meat appeal to broad human interest, while every man, woman or child who cares for plants or animals will revel in the chapters treating every phase of farm activity."

The price of the work is one dollar.

OFFICIAL PUBLICATIONS RECEIVED.

(From U.S.A. Department of Commerce, Washington.)

Natural Gas Gasoline in 1924. By G. B. Richardson and E .M. Seeley. Price 5 cents.

Natural Gas in 1924. By G. B. Richardson and H. Backus.

Barytes and Barium Products in 1924. By C. E. Siebenthal and A. Stoll. Price 5 cents.

Gold, Silver, Copper, Lead and Zinc in California and Oregon in 1924. By James M. Hill. Price 5 cents. Ditto, in Arizona, price 10 cents.

Stone in 1924. By G. F. Loughlin and A. T. Coons. Price 5 cents.

Beneficiation and Utilisation of Georgia Clays. By R. T. Stull and G. A. Bole. Price 20 cents.

Lessons from the Fire in the Argonaut Mine. By B. O. Pickard. Price 15 cents.

Analysis of Virginia Coals. Price 10 cents.

Dix Ans d'Efforts Scientifiques, Industriels et Coloniaux. 1914 1924. Sous la Direction de M. JEAN GERARD. 2 Vols. Pp. 3,000. Paris : *Chimie et Industrie*, 49, Rue des Mathurins. 1926. Price £2 8s .

The Great War wrought a profound influence upon most phases of industry, and chemistry in all its applications has been affected perhaps more than many others since its preponderating importance has been recognised on all sides. These considerations have prompted the Société de Chimie Industrielle de France to prepare this lengthy and comprehensive work on the ten years of scientific, industrial and colonial effort. The editor, M. Jean Gerard, has had the collaboration of experts in the various branches of technology for which they contribute.

The first section contains an account of the evolution of chemistry, written by Professors Urbain, Béhal, Desgrez and Lindet. The second section is devoted to descriptions of the remarkable progress made in applied chemistry in the different branches of industry. The last section of the first volume is concerned with the economic development of each industry and includes much statistical information dealing with the accomplishments of various French industries in the period under review. The work forms an invaluable and permanent record of the lessons derived from the Great War.

Chemische Technologie der Nahrungs und Genussmittel. By DR. R. STROHECKER. Pp. XI + 252. Leipzig : Otto Spauer. 1926. Price, 22 marks.

This work on the chemical technology of food products should establish itself as a valuable contribution to the literature of analytical chemistry. It gives an account of the theory and practice of analytical procedure in connection with the examination of the following commodities : meat, eggs, milk ,cheese, fats, cereals, confectionery, yeast, dough, baking powder, pulse, starch foodstuffs, greens, fungi, fruit, sugar and sweetened preparations, tea and coffee and their substitutes, beer, wine, spirits, liqueurs, vinegar, mustard, salt, spices ,mineral waters, and tobacco.

The author has had extensive experience in the examination of foodstuffs, etc., at Frankfurt-on-Maine.

Unpublished Directions for "Organic Syntheses."

The Editors of Organic Syntheses, an annual publication of satisfactory methods for the preparation of organic chemicals, now have at hand a large number of preparations in addition to those to be included in Volume 6, which is now in press, and in Volume 7, which will soon go to the printer. The following is a partial list of these preparations. Chemists interested in any of these preparations can procure copies from Frank C. Whitmore, Northwestern University, Evanston, Illinois.

Alloxan; α-Aminoisobutyric Acid; Ammonium d-α-Bromocamphor Sulphonate; n-Amylbenzene; β-Anthraquinone Carboxylic Acid; Benzoyl-o-benzoic Acid; Benzoyl Hydroperoxide; Benzyl Aniline; Diphenyl; Bromal; n-Butylamine; Cacodyl Chloride; n-Caproic Acid; Chloretone; o-Chlorobenzoic Acid; p-Chloromercuribenzoic Acid; Ethyl Cinnamate; Ethyl Nitrate; Glyceric Aldehyde; Guanidine Nitrate; Hydrocinnamic Acid; Iodobenzene; o-Iodobenzoic Acid; p-Iodobenzoic Acid; p-Iodoguaiacol; Mercury Diphenyl; o-Phthalyl Chlorides; Pinene Hydrochloride; Propionic Aldehydes; Pyrrole; Thioacetanilide; Thioguaiacol; Thiophene; α-Thiophene Arsonic Acid; Thymol Mercury Compounds; o-Toluamide; o- and p-Toluic Acids.

THE CRYSTAL STRUCTURE OF IODOFORM.

By ISAMN NITTA.

(*Institute of Physical and Chemical Research, Tokyo.*)

Among the organic compounds of chemically simple structure, iodoform CHI_3, which is regarded as the tri-iodine substituted product of methane CH_4, crystallises from acetone solution in six-sided tablets. The crystal is described as possessing the symmetry of the dihexagonal dipyramidal

class (designated by D^{h}_{3}, for which the axial ratio $a : c = 1 : 1.1084$, and the density of 4,1955 at 17° C. The present paper contains an account of the X-ray study made upon this crystal. The specimens used in the experiment were prepared by recrystallisation from acetone solution of C. A. F. Kahlbaum's " Jodoform kryst. D. A. b. 5."

The crystal structure of iodoform was studied, using the Laue photographic and the X-ray spectrometric methods. It was found that the symmetry class hitherto described is incorrect, and the proper one must be of lower symmetry most probably the hexagonal pyramidal C_6. The unit of structure built upon the hexagonal translation group Γ_h, is of the dimensions $a=6.87$, $c=7.61$ A., and contains two chemical molecules of CHI_3. Hence the density is 4.19. The plausible space group is C_6. The positions of iodine atoms are $-x, -y, \frac{1}{2}$; $x-y, x, \frac{1}{2}$; $y, y-x, \frac{1}{2}$; $x, y, 0$; $y-x, -x, 0$; $-y, x-y, 0$; where $x=0.352$, $y=0.047$. The hydrogen and carbon atoms are so arranged as to form a molecule of trigonal pyramidal symmetry C_3, the central carbon atom having the valency force distributed tetrahedrally.

FORTHCOMING EVENTS.

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FRIDAY EVENING DISCOURSES & LECTURES.

Friday, June 4, at 9 p.m.—Professor John Garstang, D.Sc., F.S.A. " Researches in Palestine."

Saturday, June 5, at 3 p.m.—Sir Walford Davies, Mus.Doc., LL.D. " The Triad and the Perfect Fourth; their Uses from Hucbald to the Preseut Day." (With Musical Illustrations.)

Monday, June 7, at 5 p.m.—General Meeting of Members.

Tuesday, June 8, at 5.15 p.m.—Brig.-General Sir Percy Sykes, K.C.I.E., C.B., C.M.G. " Chinese Turkestan and the Pamirs."

Wednesday, June 9, at 5.15 p.m.—Prof. S. Barcroft, C.B.E., F.R.S. " Lungs."

Thursday, June 10, at 5.15 p.m.—Newton Friend, D.Sc., F.I.C. " Science in Antiquity."

Friday, June 11, at 9 p.m.—Professor J. C. M'Lennan, LL.D., D.Sc., F.R.S. (University of Toronto). " The Spectrum of the Aurora."

Friday, June 18, at 9 p.m.—Seton Gordon, F.Z.S. " The Golden Eagle and its Neighbours."

INSTITUTE OF PHYSICS.

LECTURE BY MR. H. E. WIMPERIS.

We are advised by the Institute of Physics that the lecture by Mr. H. E. Wimperis on " The Relationship of Physics to Aeronautical Research," which was to have been held on May 11, will now be given on Mouday, June 7, at 5.30 p.m., in the Physics Lecture Theatre, Royal College of Science, South Kensington. Members of the Society are invited to attend. Tickets of admission will not be required.

THE INSTITUTE OF MINING ENGINEERS.

NOTICE OF POSTPONEMENT OF GENERAL MEETING.

The General Meeting, provisionally arranged to be held on June 15, 1926, and following days at Newcastle-upon-Tyne, has been postponed to a date, possibly in the early Autumn, to be announced later.

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11	1866	266, 268
12	1865	317
13	1866	318-324, 326-328
14	1866	355
15	1867	370-373, 378, 387.
16	1867	412
18	1868	472
19	1869	489
21	1870	528-532
25	1872	632
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31	1875	788, 789
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SILVER CARBONATE.

By G. H. JEFFERY AND A. W. WARRINGTON.

[This paper deals with a quantitative study of the composition of "pure" silver carbonate, and of the decomposition of this substance by heat.]

Baker has shown how extremely difficult it is to expel the last trace of moisture from such elements as bromine, and such compounds as phosphorus pentachloride, and ammonium chloride, and we are also acquainted with substances which cannot be deprived of water without decomposition.

In the preparation of pure silver carbonate, and in the attempt to prepare silver oxide, the writers have come across excellent examples of the pertinacity with which some compounds refuse to be deprived entirely of moisture.

(a) Silver carbonate prepared in the cold and dried over sulphuric acid, or phosphorus pentoxide, until the weight is constant, still contains some water.

In nine experiments, in which the total weight of carbonate was 69,1453 gm., the total amount of water was 0.0821 gm., or 0.119 per cent. The least amount of water was 0.043 per cent., and the greatest 0.246 per cent.

(b) The carbonate cannot be prepared pure in the boiling solution, and then dried at 100°, nor can it be prepared in the cold, dried over sulphuric acid, *and* then further heated to 100°. Four experiments with the carbonate prepared as above yielded the following results :—

Experiment.	Carbonate.	Silver.	Per cent. of silver.
X	4.5959	3.6196	78.76
Y	1.9356	1.5245	78.76
2	14.0220	11.0181	78.58
3	11.1955	8.8207	78.79
	Calculated		78.24

In all four experiments the carbonate was dried in a steam oven until its weight was constant. X and Y were prepared in the boiling solutions, and 2 and 3 in the cold, and dried over sulphuric acid.

(c) If the carbonate is heated to 180° until the weight is constant, the product will be found to contain not only the oxide, but some undecomposed carbonate, *and* water.

Experiment	Product after heating carbonate to 180°	Metal	Carbon dioxide	Water
4	9.3681	8.7459	0.0147	0.0048
6	11.5671	10.8210	0.0194	0.0064

Deducting the water, and correcting for weighing in vacuo, *assuming* that the specific gravity of the oxide was *equal* to that of the weights used, we get :—

Experiment	"Oxide"	Metal	Carbon dioxide
4	9.3633	8.7457	0.0147
6	11.5607	10.8207	0.0194

These figures give the composition of the two as follows :—

	Experiment 4.	Experiment 6.
Silver oxide	92.45	89.40
Silver carbonate ...	0.98	1.05
Silver	6.57	9.55

PREPARATION OF SILVER CARBONATE.

Silver carbonate was prepared, *as recommended by L. Joulin*, by adding a solution of sodium carbonate to an excess of a solution of silver nitrate in the cold. After being well washed—no trace of nitrate was found in the precipitate—the moisture was removed as much as possible, by dumping the paper containing the precipitate on a series of pieces of filter paper. The filter paper containing the precipitate was then placed in a desiccator and dried for several weeks over sulphuric acid. The precipitate was then removed to a quartz basin, reduced to a powder, and allowed to stay in the desiccator until the weight was constant.

In the last three experiments all operations, except the actual analysis, were conducted in a room lighted only with a red lamp. The desiccator was placed in a light-proof box.

The materials were provided by Messrs. Harrington as specially pure. The silver

used was assay silver, and the nitric acid and the sodium carbonate were quite free from chlorides. After dissolving the silver in nitric acid, most of the excess of nitric acid was expelled from a water bath, the nitrate being in a quartz basin. The remaining excess of nitre acid was neutralised with sodium carbonate.

The silver carbonate, prepared in a red light, was found to have a pure sage-green colour, and *after* drying was only slowly and slightly affected even by strong sunlight. When damp the carbonate rapidly darkens in the light, but analysis showed that this was accompanied by little decomposition, if any.

The Decomposition of Silver Carbonate by Heat.

The larger weights were of brass, and the smaller ones of gold and platinum, and were provided by Messrs. Becker and Co. They were carefully examined and found to be correct to the tenth of a milligram.

All weighings were made on both pans of the balance, and the mean of the two weights taken. The calcium chloride tube, and the caustic potash bulb, to estimate the water and carbon dioxide respectively, were weighed with exactly similar vessels used as counterpoises. A blank experiment showed that the weights of water and carbon dioxide could be estimated correctly to *one milligram*.

The last three experiments, of which alone full data are given, were conducted as follows :—Oxygen, from a cylinder, was passed through strong sulphuric acid, and over caustic potash, through a quartz tube, then through the calcium chloride tube and its counterpoise, through the caustic potash bulb and its counterpoise, placed in series. The quartz tube was heated. When the whole apparatus was full of oxygen, the tube was allowed to cool, and the calcium chloride tube and the caustic potash bulb were removed for weighing. Oxygen was allowed to pass through the quartz tube, while the weighings were made, to prevent moisture and carbon dioxide entering the apparatus. The silver carbonate was then placed in a quartz boat, and the boat pushed into the quartz tube, the calcium chloride tube, and caustic potash bulb placed in position, and the carbonate subjected to a heat sufficient to decompose it but not to fuse the silver formed.

Nine experiments were made, some of the earlier ones under slightly different conditions. The uncorrected results were 78.244 ± 0.013 per cent. of silver, and 15.982 ∓ 0.038 per cent. of carbon dioxide. Taking the specific gravity of the carbonate to be 6.0 (C. J .B. Karsten gives 6.0766, and P. Kremers, 6.0), these figures reduced to weighing in vacuo would give

	% found	% calc.
Silver	78.237	78.242
Carbon dioxide ...	15.992	15.956

By adding together the quantities taken in all the experiments, we find 69.0631 gm. of the anhydrous carbonate yielded 54.04275 gm. of silver and 11.0149 gm. of carbon dioxide. These figures give : Silver, 78.251 (uncorrected), and Carbon dioxide 15.949 (uncorrected), or Silver 78.244 and Carbon dioxide 15.959 (reduced to weighing in vacuo). Taking the equivalent of carbon dioxide to be 22, these figures would give the atomic weight of silver to be 107.86, which is so near the accepted value that one can hardly refrain from believing that, in abler hands, the analysis of silver carbonate would furnish a reliable method of confirming the atomic weight of silver. Our readers are asked not to forget that the above work was done in a school, and that both writers were working under the usual school conditions. These considerations, it is hoped, will disarm those who might otherwise, with justice, criticise this paper because of the largeness of the probable error.

Full details of the last three experiments, which the writers believe to be the best, are given below.

Expt.	Moisture containing carbonate	Metal	Carbon dioxide	Water
11	5.32515	4.15935	0.8471	0.0086
12	6.7783	5.2964	1.08635	0.0094
13	5.9849	4.6755	0.95625	0.0076

Results corrected except for weighing in vacuo—

Expt.	Carbonate	Metal	Carbon dioxide
11	5.31655	4.15935	0.8471
12	6.7688	5.2964	1.08635
13	5.9773	4.6755	0.95625

These figures give the following percentages (uncorrected for weighing in vacuo)—

Expt.	% of Silver		% of carbon dioxide
11	78.234	...	15.938
12	78.247	...	16.049
13	78.221	...	15.998

Corrected for weighing in vacuo—

Expt.	% of Silver		% of carbon dioxide
11	78.227	...	15.943
12	78.240	...	16.059
14	78.214	...	16.008
Calculated	78.242	...	15.956

The writers wish to thank Mr. Page, of the Rothamsted Experimental Station, for useful criticism of the work while in progress.

Taunton's School,
Southampton.

THE SYNTHESIS OF CAMPHOR AND MENTHOL.

By John Missenden, B.Sc.

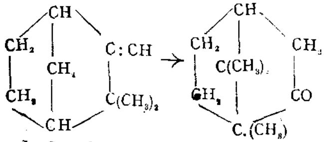
The most important point to be taken into consideration when considering the camphor group is that its members are partly monocyclic and partly bicyclic. The main compounds which concern the present article are: in the monocyclic division, citronellal, menthone, menthol, pulegone, *iso*pulegone, *iso*pulegol, and the borneol products; and in the bicyclic division, camphor, camphene, and the associated products.

It should be remembered that, in a commercial sense, synthetic camphor presents considerable differences to the so-called artificial camphor, the latter being but pinene hydrochloride, a compound that is seldom suitable for the uses to which natural or synthetic camphor may be put. The production of artificial camphor is brought about by leaving the synthesis of true camphor unfinished—it is, therefore cheaper.

Synthetic camphor is obtained primarily from oil of turpentine, and the greater the pinene content of this oil, the better. It is not very difficult to obtain one yielding as much as 85 per cent. The first step is to produce the hydrochloride of pinene by allowing a stream of dry hydrochloric acid to ascend through the turpentine, when the solid compound will at once separate. This solid will be found to contain much acid which must be cleared by treatment with, say, pyridene; and when this process is complete, *camphene* will result.

Camphene.

From this point, the reactions may take two courses, both resulting in camphor. The first is to oxidise camphene by direct treatment with chromic acid. The complete process is in accordance with the following formulæ :—



I—Camphene. II—Camphor.

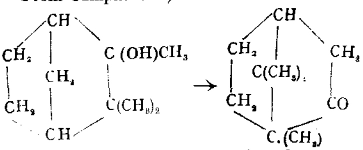
Much doubt has been expressed as to whether the involved double ring for camphor is the correct one, as the process is a simple oxidation; but such doubt is more than satisfied by the facts that such wide molecular arrangement is quite usual in compounds of this group, and that the camphene formula can be verified during the production of camphenic acid (q.v.).

The oxidation products of camphene are fairly numerous, camphor being, of course, of primary importance. Another, *camphenilone*, is produced by the action of ozone.

The second method of obtaining camphor is not quite so brief; at the same time, the opinion has been expressed by a collaborator (H. E. W.), that the camphor so made is more stable. The method consists in treating the camphene with dilute sulphuric and glacial acids to produce *iso*borneol.

By this method a complication arises. The camphene under the mixed acids forms *iso*borneol at once, but this is immediately passed to another compound, and *iso*borneol is only obtained again by boiling with alcoholic potash. The final stage is one of oxidation :—

From Camphene →



III—Isoborneol. IV—Camphor.

Although the writer has not yet had any occasion to make the attempt, he is of opiuion that a good yield of camphor can be obtained by the oxidation of camphene with ozone.

The Camphor Acids.

The two most important oxidation products of camphor are camphoric acid ($C_{10}H_{16}O_4$) and camphoronic acid ($C_9H_{14}O_6$). Just as *iso*borneol (and borneol, incidentally) was able to be oxidised into camphor, so may camphor be reduced by sodium and alcohol into *iso*borneol. Camphoric acid is obtained by simple oxidation employing any familiar method; but a good idea of its potentialities may be derived from the following somewhat interesting synthesis: " β-β-dimethylglutaric ester is used to condense ethyl oxalate into the corresponding diketo-apocamphorate. This, in turn, is subjected to methylation by methyl iodide and metallic sodium, and further subjected to phosphorus. The dehydrocamphoric acid so produced is brominated and reduced, the result being camphoric acid. The process appears to be as follows :—

From diketo-apocamphorate →

$CH.C(CH_3)—COOH$
‖ $> C(CH_3)_2$ →
$CH.CH—COOH$

V—Dehydrocamphoric acid.

$CH_2.C(CH_3)—COOH$
| $> C(CH_3)_2$ →
$CHBr.CH—COOH$

VI—(Brominated compound, probably β-Bromo-camphoric acid).

$CH_2.CH—COOH$
| $> C(CH_3)_2$
$CH_2.CH—COOH$

VII—Camphoric acid.

Camphoric acid may be converted into camphor by Haller's method (*Compt. rend.*: 1896, 446). (Abstracted from a private process book).

The second acid (which may be considered as of ααβ-trimethyl-carballylic constitution) is easy of synthesis, apart from the direct oxidation of camphor. Zinc should be added to a mixture of α-bromo-*iso*butyric ester and aceto-acetic ester, which forthwith convert to β-hydroxyglutaric ester. Further conversion takes place by treatment with chlorine and cyanogen, following with hydrolysis to camphoronic acid. The process is :

From the two esters →

$(CH_3)_2C$——COOH
|
$C(CH_3)(OH)$ →
|
CH_2—COOH

VIII—β-Hydroxy-glutaric ester.

$(CH_3)_2C$——COOH
|
$C(CH_3)$—CN →
|
CH_2—COOH

IX—(Cyanogen ester).

$(CH_3)_2C$——COOH
|
$C(CH_3)$—COOH
|
CH_2—COOH

X—Camphoronic acid.

It is possible to obtain an *iso*keto-camphoric acid and an *iso*camphoronic acid from camphoroxime. The process involves the production of α-campholenic acid by dehydration, followed by oxidation. α-Campholenic acid has a β-isomer.

Menthol.

It is somewhat curious that menthol is not manufactured synthetically from camphor or any of the camphor group, although it is definitely a camphor itself. The most favoured method of production is from Japanese peppermint oil, which can yield from 80 to 90 per cent. of good menthol; but this is only the natural menthol, and the fact that it is highly purified hardly justifies it being referred to as a synthetic product.

Two methods of producing synthetic menthol have been investigated by the writer and his collaborators. The first is a synthesis from citronellal. This synthesis produces a menthol of most excellent quality, having a crystal melting point of 41° C.; and it is quite practicable. There are two well-marked stages in the process. The first is the action upon citronellal of (successively) acetic anhydride and barium hydrate, with the production of pulegone. The second stage consists of heavily brominating and reducing pulegone, when menthone is formed. The reduction of menthone gives menthol.

The second method is far shorter, rhodinal oxime being treated with acetic anhydride to give menthone direct.

The menthol so produced is optically inactive, and shows the true 5-methyl-2-isopropyl hexahydrophenol (oxyhexahydrocymeme) configurations which pass readily into Δ^3-methene when subjected to phosphorus pentoxide.

The writer is indebted to Drs. Raydor and Waëtz and to the Bremen Essential Oil Works for assistance in preparing and permission to publish the interesting processes in this paper.

THE CHANGE OF THE WAVE-LENGTH OF THE CADMIUM RED-LINE (λ 6438.7 A).

By Mitsuharu Fukuda.

(Scientific Paper from the Institute of Physical and Chemical Research, Tokyo.)

Recently, the author has examined the change of the wave-lengths for certain lines of zinc, cadmium and mercury in a condensed discharge. In that experiment, it was observed that the wave-lengths of theh certain lines produced in a heavy condensed discharge were shifted from those produced in an arc-like discharge.

The change of wave-length, however, might occur because of a slight difference in the conditions of the excitation, *e.g.*, the circuit having a small self-inductance or a small spark gap due to loose contact of the switch. But as the amount of the wave-length may be very small, a fraction of an angstrom, it is well known that the amount of the shift may be observed only when the high resolving power spectroscope, such as the interferometer, is used. But, for this experimental aim, the ordinary interferometers such as Fabry-Perot, Etalon and Lummer-Gehicke plane parallel plate, are unusable because they give definite interference only when the light source is very intense and pure. Accordingly if we employ the above interferometer for the present purpose, the light through it appears very faint so that in order to secure a distinct image on a photographic plate a very long time of exposure will be required. Moreover, the conditions in the discharge tube, such as the temperature, pressure, etc., may vary during this period. Therefore, an ordinary interferometer should not be employed at all for the present experiment.

Fortunately, Prof. H. Nagaoka recently invented a very convenient interferometer, known as an "Interferential Prism," through which the image of the interference fringes appeared very bright though the light source was not so intense.

The author secured permission to use this "Interferential Prism" and the experiment was made satisfactorily.

The wave-length of the cadmium red-line λ 6438.7 A. produced by the indnstive circuit and non-inductive circuit was compared, according to the method as given below.

The "Interferential Prism," instead of the prism belonging to the apparatus, was mounted on the Zeiss "Licht-Stark Spektrograph" and the spectrum was adjusted at minimum deviation for the cadmium red-line. The wave-length of the cadmium red-line was examined minutely by comparing the interference fringes. As the light source, an ordinary Geissler tube excited by 1-kW Thorderson transformer was used. In the circuit of the discharge, a self-inductance of 8×10^{-4} henrys was inserted or taken off by means of a change-over switch. The image of the capillary of the tube was focussed by the Zeiss Tessar photographic lens of 10-cm. focal length on to the slit distinctly and by the wider aperture of the slit the light from the tube excited by an inductive circuit was photographed and then, by narrowing the slit, the light that issued from the non-inductive circuit was taken on the previous image, or sometimes conversely. As the slit was a symmetrical one and the aperture of the slit was adjustable by means of a fine screw, not even a slight disturbanee was introduced by narrowing or widening it. As the time of exposure was only 5-seconds

in maximum, it is probable that the conditions in the discharge tube have not changed during the exposure.

From the measurements of the several plates it was found that the amount of the change of the wave-length was as follows: -0.044 A.U.

The minus sign shows that the wave-length shifted toward the red-side when the self-inductance was removed from the circuit. In the experiment the current from the trausformer read 600 milliamperes by hot-wire ammeter.

The standard meter was evaluated in terms of a cadmium red-line λ 6438.7 A., which is extremely homogeneous; a broad line or a line accompanied by satellites will, of course, not produce satisfactory interference fringes. This evaluation was worked out by Michelson in 1892, and later by Benoit, Fabry and Perot. A study of the nature of the cadmium red-line, therefore, is of great importance. It is desirable to examine more minutely into the nature of this problem.

General Notes.

THE INFLUENCE OF IONS CARRYING THE SAME CHARGE AS THE DISPERSED PARTICLES IN THE INVERSION OF EMULSIONS.

This is the title of a paper by S. Ghosh and N. R. Dhar (University of Allahabad) published in a recent issue of the Journal of Physical Chemistry. The summary of the paper is as follows:—

1. It is shown that an oil emulsion closely resembles a colloidal suspension and the generalisations advanced for a sol is followed by an emulsion.

2. The separation of oil-in-water emulsion into two layers can be regarded as the coagulation of the dispersed oil globules. The reversal of phase of oil-in-water is probably the dispersion of water particles carrying a positive charge in the oil.

3. From the experimental results of various workers it is concluded that salts like NaCl, KCl, Na citrate, NaOH, etc., favour the formation of an emulsion of the type oil-in-water. This shows that anions, viz., Cl', Cit''', OH', etc., are appreciably adsorbed by the oil globules.

4. It has been deduced that the adsorption of the anions is mainly responsible for the antagonism observed between the electrolytes of monovalent cations like NaCl, KCl, NaOH, etc., towards salts of bivalent and trivalent cations like $Ba(NO_3)_2$ $AlCl_3$, $Al_2(SO_4)_3$, etc., on the inversion of an oil emulsion.

5. It is shown that the (a) abnormal dilution effect, *i.e.*, more of an electrolyte is necessary to coagulate a dilute emulsion than a concentrated one, and (b) the antagonistic effects observed between salts of monovalent cations and bivalent cations on the inversion of the types of the smulsion are essentially connected and go hand in hand. This generalisation has already been advanced by us in a series of papers for ordinary sols.

6. It has been emphasised that the stability of an oil emulsion in the presence of soaps mainly depends on the electric charge of highly adsorbed soap micelles.

NONFLAMMABLE LIQUIDS FOR CRYOSTATS.

By W. KANOLT.

Several very serious accidents in laboratories have resulted from the use of flammable liquids, such as volatile petroleum distillates, or toluene, to form the bath of a cryostat. In some instances explosions have occurred, and burning liquid has been thrown upon the operator.

The purpose of the investigation has been to find liquids that will not burn, that have very low freezing points, and that are otherwise suitable for use as cryostat liquids. The materials tried were chlorine and bromine derivatives of methane, ethane, and ethylene, and mixtures of these derivatives. By mixing the substances in suitable proportions, it is usually possible to obtain mixtures having lower freezing points than those of any of the constituents. The eutectic compositions and temperatures of mixtures of two, three, and four components have been determined, and some mixtures of five components have been investigated.

Some of the mixtures became very viscous at temperatures near their freezing points, and the limits of usefulness of these mixtures were determined by their viscosities rather than their freezing points. For this reason the viscosities of some of the mixtures were measured, at various

temperatures. The corrosiveness of the liquids to metals was also studied.

Lquids that will not burn and are suitable for use at temperatures down to about – 150° C. are described.

Apparatus is described for the determination of freezing points at low temperatures, with special means of avoiding the presence of solid particles in the liquid.

—*Bulletin* No. 520, issued by the U.S. Bureau of Standards. (Price 10 cents.)

FIRST PRODUCTION OF TIN IN CANADA.

Tin is being recovered commercially for the first time in the history of mining in Canada by the Consolidated Mining and Smelting Company, of British Columbia. The output, which is from one-half to two tons per day in the form of cassiterite, is recovered as a table by-product from its Sullivan mine ore. A number of tin ingots were first made in the Company's laboratory.

NORTH ONTARIO SILVER MINES.

HUNDRED MILLION IN DIVIDENDS.

With recent declarations, dividends paid by Northern Ontario silver mines top the $100,000,000 mark. Cobalt profits have supplied about 97% of the dividends. The total sum includes $6,000,000 profits from private corporations, a figure which is very conservative. Total gold and silver dividends this year will reach $12,000,000, as compared with $10,120,974 paid last year, which created a record.

A feature is the way the Kirkland Lake dividend payments are growing. This year the mines in that camp may be expected to distribute $2,500,000, as compared with $1,150,000 in 1925, and $586,250 in 1924. By the end of 1926 Kirkland distributions should aggregate $600,000,000, and Porcupine dividends $55,000,000. The latter camp will distribute about seven and a half million dollars this year.

The Mellon Institute of Industrial Research, of the University of Pittsburg, has just issued the fourth Supplement to the Bibliographic Series. It contains a list of the Bulletins, Journal contributions, and Patents by members of Mellon Institute of Industrial Research which have appeared or been taken out during the year 1925.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE CHEMICAL SOCIETY.

Thursday, June 3.

The Determination of the Atomic Weight of Silver by the Direct Ratio of Silver to Oxygen in Silver Oxide. By H. L. RILEY AND H. B. BAKER.

Preliminary experiments showed that it was possible to prepare silver oxide and dry it at 100° without any measurable volume of oxygen being evolved in the process. The dried oxide, however, on treatment with dilute hydrochloric acid always gave a pink chloride, indicating a loss of oxygen. Gravimetric experiments proved this loss to be considerable. Further investigation proved that this loss of oxygen was not due to the instability of the oxide at the temperature of drying but to the reduction of the oxide by organic matter present in the reagents used.

An apparatus for the precipitation (using barium hydroxide and silver nitrate) filtration and washing of silver oxide in an atmosphere of air which had been passed over red hot copper oxide, is described. Silver oxide prepared in this apparatus and dried for two months over sodium hydroxide gave, on being treated with hydrochloric acid, a perfectly white chloride. The removal of the last 0.3% of water from the precipitated oxide was impossible and allowance was made for this in the determination of the ratio Ag : O.

In the determination of the ratio, a weighed quantity of the oxide was decomposed by heat, the residual silver melted in hydrogen and weighed. The mean result of six determinations was 107.864 .0013.

The Structure of Silver Oxide. By H. L. RILEY.

During the experiments on the atomic weight of silver, it was noticed that the amount of water left in the silver oxide after prolonged desiccation was surprisingly constant. In twenty-four samples of oxide which had been dessicated for periods varying from two to eight months, the percentages of water only varied between 0.46 and 0.27. Experimental and theoretical evidence has been put forward to show that this water is present combined with the silver as silver hydroxide, each small particle of oxide being surrounded by a unimolecular film of hydroxide. The structure

of such a surface film is shown to agree with the views on the crystal structure of silver oxide.

Some Derivatives of Naphthaquinolines and Naphthaisoquinolines. By C. S. Gibson, K. V. Hariharan, K. Narayana Menon, and J. L. Simonsen.

The difficulties previously encountered in the preparation of dl-2-*methyl*-1 : 2 : 3 : 4-*tetrahydro-α-naphthaquinoline*, have been overcome and, in addition, dl-4-*methyl*-1 : 2 : 3 : 4-*tetrahydro-α-naphthaquinoline* has also been synthesised starting from α-naphthylamine and ethyl aceoacetate. Similarly, dl-2-*methyl*-1 : 2 : 3 : 4-*tetrahydro- -naphthaquinoline* has been prepared in quantity.

Unlike α-naphthylamine, 4-bromo-α-naphthylamine, 4-nitro-α-naphthylamine and 4-aminoacenaphthene correspond in their condensation with paraldehyde with β-naphthylamine.

Starting from α- and β-naphthaldehydes respectively, 4 - *methyl* - 1 : 2 - *dihydro-β-naphthaisoquinoline* and 1-*methyl*-1 : 2-*dihydro-α-naphthaisoquinoline*, have been synthesised. Naphtha*iso*quinoline derivatives do not appear to have been previously described.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

Organic Theories of Oil Origin. By Ernest Clarke (Student Member).

(*Extract of a paper read at the meeting at the Royal Society of Arts on Tuesday, May 25, 1926, at 5.30 p.m.*) This paper was awarded the Students' Medal and Prize, 1924.25-.

In studying the subject of the origin of petroleum one is impressed by the lack of proportion between theory and fact, and it is very evident that progress towards the solution of this fascinating problem will best be assured by the careful investigation and analysis of the facts of petroleum occurrence, not only with regard to the origin itself, but to the closely related snbjects of migration and accumulation. In view of the general lack of detailed knowledge, this paper cannot pretend to be other than the sketchiest of outlines; its underlying idea is the unification of existing theories rather than detailed critical consideration of them.

Of late years, it has come to be generally realised that oil formation is at least as normal a phase of sedimentation as that of coal; and just as coal is the product of decomposition of terrestrial vegetation, so presumably is oil the result of similar decomposition of other organic materials. It is convenient to divide the subject into two parts—deposition and chemical change.

Plants.—Algæ, diatoms and bacteria comprise the chief planktonic plants, and many forms are benthonic; they are abundant in fresh and salt water and are very widely distributed. The seaweeds are mainly marine benthonic types, often of large size and characteristic of the Laminarian zone (0-15 fa); others, such as the Sargassum, are floating forms. The water ferns (rhizocarps) grow or float in fresh water, are most abundant in the tropics, and their spores, etc., are widely distributed by flotation. The grasses are mainly terrestrial and fresh-water, though some are shallow marine benthonic—*e.g.*, salt marsh grasses.

Both plants and animals consist largely of proteins, fats and carbohydrates iu varying proportions, but carbohydrates, particularly cellulose, are more characteristic of the plants, and proteins usually bulk largely in the animals. Though the forms of life are of very different organisation and habitat, there is, on a chemical basis, a degree of uniformity which makes unreasonable the award of pre-eminence to a restricted few in the formation of petroleum. Restriction will depend almost entirely upon envorinmental considerations. If any distinction for the mother substance of oil is to be made it should be a chemical one, *e.g.*, the fatty substances, owing to their nature and resistance to putrefaction, might conceivably be regarded as a main source—whether they originated in foraminifera or algæ. Some organisms actually contain hydrocarbons, but the percentage is so small as to be negligible.

Once the organic matter is buried in mud the restriction of circulation prevents the access of oxygen, and arrests oxidation. A sndden increase in supply of sediment therefore not only causes high mortality among organisms, but ensures favourable conditions for their entombment and preservation. Such fluctuations may be due to diastraphism or simply to seasonal or periodic variation of climate, and their effect is intensified in the case of gulf or

inland sea conditions owing to the focussing of the drainage. The occasional deposition of arenaceaus horizons over the clays would be a natural result, the more widespread sands being attributed to oscillation.

The redeposition of oil itself in association with mud particles has been noticed; and the coagulation in salt water of the solnble organic matter (humic acids, etc.) accompanied by colloidal silica in some rivers, may contribute to the organic materials.

In considering all these natural phenomena it is important to remember that the balances of inflnences which constitute an environment is constantly changing, due to their own operation; *e.g.*, unless the infilling of a gulf by sediment be constantly offset by subsidence, the gulf will gradually disappear. Slow subsidence not only increases the areal extent of an environment, but allows the deposits, especially those of deltaic or shallow lagoon characters, to attain considerable thickness. The subsidence effect will, however, largely depend on the original topography of the areas involved.

The almost universal association of petroleum with brine may be due not only to the fact that meteoric waters usually dissolve the salts from sediments, but that where meteoric circulation is possible oil and gas tend to be removed.

Coal and Oil.—It may be regarded as proved that coal is essentially the product of terrestrial vegetation, deposited in peat bogs and marshes or transported under marine or freshwater conditions. Marine animal and plant life are the only other types of organic matter which can form an important constituent of sediments, and petroleum is likewise the other form of hydro-carbon occurring in sedimentary rocks; hence a close connection between the two would be surmised and this is supported by the following generalisations :—

(1) Petroleum occurs more commonly in rocks of marine origin and is intimately associated with their connate brines.

(2) It is chemically possible to obtain petroleum from most types of organic matter, and presumably under such conditions as occur geologically.

With these premises it is possible to form some idea of the depositional relationship of oil and coal, and possibly by comparison and test, to learn more of both.

The factors which determine the ultimate composition of a crude petroleum may be classified as follows :

The nature of the parent substance, its environment and deposition.

The types of chemical reaction which transform the organic matter to petroleum hydrocarbons.

The modifications caused by contact of the petroleum with rocks and underground waters during migration.

Whatever variation of opinion there exists with regard to the details of the processes involved in the generation of petroleum, there can be no doubt of certain general conclusions based on broad geological and chemical facts.

It is useless to assert, for instance, that marine environments do not provide conditions for the preservation of organic matter, when the bulk of the world's oil supply is derived from sediments of marine origin.

Chemical Change.

The first chemical changes which occur in the organic matter are undoubtedly putrefactive, in most cases aerobic at first, in others anaerobic from the commencement. Bacteria living under anaerobic conditions may derive their oxygen from the organic substances of which it is a constituent, forming hydrocarbons and organic sulphur, nitrogen and phosphorus compounds—chiefly hydrides. The chemical effect of bacteria seems to be due to the catalytic action of the enzymes which are produced; and anaerobic bacteria can cause oxidation or reduction according to the presence of hydrogen or oxygen acceptors. The bacterial changes are accomplished rapidly, compared with the exceedingly slow geological distillation or devolatilisation due presumably to weight and thrust pressure and assisted by depth temperature.

A logical conclusion of the formation of oil mainly by pressure—heat—time distillation would be an original direct relationship of the degree of metamorphism and grade of oil produced—the distillate varying as the composition of the mother substance constantly altered, *or* presuming methane to be the main product, the degree of polymerisation depending on concentration and pressure. In the Appalachian geosynclinal, the main coal series occurs above the oil series and the degree of metamor-

phism as measured by the carbon content of the coals (ash free) has been correlated with the grade of oil beneath.

The chief avenues of research would seem to be :—

(*a*) Physiographical, involving scientific investigation of sediments which are forming at the present day, particularly such types as are indicated in the first part of this paper.

(*b*) Geological, involving an enlargement of detailed knowledge of the lithology and palæogeography of petroliferous sediments and the factors controlling the movements and behaviour of oil, gas and brine in them.

(*c*) The chemical problems would probably be outlines from the results of (*a*) and (*b*).

It is evident that a problem of this magnitude, involving specialisation in several distinct branches of science, can only be satisfactorily solved by the closest collaboration of all investigators.

The task of patiently accumulating information relation to oil origin could be admirably carried out by such an institution as this, for it is only by co-operative effort that the collection of adequate evidence to substantiate any general theory could be achieved.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Low-Frequency Intervalve Transformers. By P. W. Willans, M.A.

Summary.

The theoretical expression for the voltage amplification of a valve followed by a transformer is developed in its simplest possible terms, and various particular cases are considered. The importance of low leakage inductance for the uniform amplification of the higher frequencies is emphasised.

A practical verification of the theory is provided by actual measurements of the vector amplification ratio and comparisons with the theoretical equations, and graphical methods are given whereby the constants of a transformer can be deduced from these measurements and the amplification ratio extrapolated to frequencies beyond the range of convenient measurement.

A practical design of transformer is described in which low leakage inductance and self-capacity are ensured by a sectionised and spaced construction, and a curve of amplification of this transformer is given.

Various questions relating to intervalve transformers are briefly considered and circuits are described for increasing the amplification of low frequencies and the effective step-up ratio of the transformer.

The use of low-frequency reaction for correcting distortion is described and illustrated by measurements.

GEOLOGICAL SOCIETY OF LONDON.

May 19, 1926.

The President announced that, in his capacity as President of the Society, he had consented to serve on a Committee which is being formed to erect a monument to Jules Marcou at Salins (Jura), his birthplace.

The President stated that, on July 10, he would unveil a tablet in memory of William Smith, at the house where Smith resided during his sojourn in Bath.

The following communications were read :—

A Revision of the British Carboniferous Murchisoniidæ, with Notes on their Distribution, and Descriptions of Some New Species. By Jane Longstaff (*née* Donald) F.L.S., F.G.S.

Reference is made to the genotype, *M. turbinata* Schlotheim, and figures are given of the aperture of two species in De Verneuil's Collection, Paris, showing the characteristic slit in the outer lip.

Six new species and one variety are figured and described, as well as five species recorded by L. G. De Koninck in Belgium, which, with one exception, had not been previously noted in the British Isles.

The holotypes of all the species are indicated, and the collections in which they are placed; also additional localities are given.

Altogether fifty-two species and one variety have been recorded, which are referable to five other genera and subgenera besides *Murchison* sensu stricto. The greater number belong to the genus *Hypergonia*, of which the distinctive characters are especially pointed out, as they are clearly exhibited in well-preserved Scottish

examples, some of which are almost complete from apex to aperture.

Seventeen species are common to Belgium, all of which are Viséan except three, two being Tournaisian and one Waulsortian.

Scotland has the most species; and so far twenty appear to be peculiar to that country, nine to England, and one to Ireland.

The greater number of British species are of *Dibunophyllum* age, only eight being from lower and two from higher zones.

The Carboniferous Limestone (Avonian) Succession of a Portion of the North Crop of the South Wales Coalfield. By THOMAS NEVILLE GEORGE, M.Sc. Communicated by Dr. A .E. Trueman, F.G.S.

A description is given of the lithological and faunal succession of the Avonian along some 30 miles of the North Crop between Kidwelly and Penwyllt (Tawe Valley).

SOCIETY OF PUBLIC ANALYSTS.

AND OTHER ANALYTICAL CHEMISTS.

An additional Ordinary General Meeting of the Society of Public Analysts was held at the Chemical Society's Rooms, Burlington House, on Wednesday, June 2, 1926, the President, Mr. E. Richards Bolton, being in the chair.

Certificates were read for the first time in favour of Mr. Stafford Aston, F.I.C.

Certificates were read for the second time in favour of Messrs. Francis Harrold Banfield, M.Sc., Ph.D., A.I.C., and Albert Lester Williams, A.I.C.

The following were elected Members of the Society—Messrs. Arthur Barraclough, B.Sc., A.I.C., George Elkington, Kenneth Massy Griffin, M.Sc., A.I.C., Herbert Firth, A.I.C., and Thomas Pickerill, B.Sc.

The following paper was read :—

Problems in Connection with Ancient Egyptian Materials. By A. LUCAS, O.B.E., F.I.C.

ABSTRACT.

The author deals with the more important materials discovered in Egyptian exploration. The nature of the patina on prehistoric flint implements, and its probable mode of formation are described. The composition of faience and the problems of how its body materials were held together, the nature of ancient Egyptian glass and its pigments, and problems connected with pottery are then discussed. Analyses of metal objects and examples of their use in discovering the probable origin of the different metals are given. Other problems discussed are those connected with the identification of oils and fats, with the resins used for embalming mummies, the effect of burial on human hair, textile fabrics and their decay, and the examination of stone.

A discussion followed.

THE PHYSICAL SOCIETY OF LONDON.

Proceedings at the Meeting held on Friday, May 28, 1926, at the Imperial College of Science, F. E. Smith, C.B.E., F.R.S., Vice-President, in the chair.

The following paper was read :—

Static and Isotropic Gravitational Fields. By G. TEMPLE, Ph.D., Imperial College of Science.

ABSTRACT.

The object of the paper is to give a brief account of Einstein's General Theory of Relativity as applied to those problems in which they have received their most striking confirmation. By limiting the investigation to the consideration of dynamical manifolds which are static and isotropic in character it has been found practicable to abandon the notation and theory of the Absolute Differential Calculus, and to substitute in its place some classical theorems of Lord Kelvin and M. J. Liouville. The simplified theory thus obtained serves to explain the construction and solution of Einstein's field equations, and their application to the problems of planetary motion, and of the deviation of light in a gravitational field. It also serves to make explicit the various assumptions involved in Einstein's theory.

A RADIOMETRIC INVESTIGATION OF THE GERMICIDAL ACTION OF ULTRA-VIOLET RADIATION.

By W. W. COBLENTZ AND H. R. FULTON.
(*Bureau of Standards, Washington, D.C., U.S.A.*)

ABSTRACT.

Although the literature is replete with reports of investigations of the germicidal action of ultra-violet radiations but little information is at hand regarding the energy relations involved.

In the present investigation an attempt is made to determine the energy relations involved in abiotic action, thus placing the results upon a radiometric basis. By means of screens of mica, and of glass, successive portions of the ultra-violet spectrum are eliminated and the effects upon the resulting germicidal action established. The novelty in the present investigation consisted in making an application of the discovery that mica has a well-defined absorption band at about 260 mμ. A small variation in thickness of the mica screen produces a large variation in transmission in this spectral region relative to the rest of the spectrum, thereby permitting an increase in the intensity of the radiation stimulus of these wave lengths, while other conditions remained practically constant.

The effects of pre-exposure of the culture medium upon subsequent inoculation were investigated, and found negligible for the intensities and the time of exposure used in this investigation.

The paper gives data on (1) the effect of continuous and of intermittent exposure; (2) the spectral range of, as well as the effect of the intensity of the radiation stimulus upon abiotic action; and (3) the energy required to kill a bacterium.

For low intensities a stimnlation of bacterial growth may possibly occur, which is a question requiring further investigation.

In the present investigation an attempt is made to present the results on a radiometric basis, which seems to be the logical procedure in order to obtain some estimate of the germicidal action of different parts of the spectrum.

The subtractive and additive method of attacking the problem was used. The subtractive principle consists in eliminating different portions of the ultra-violet spectrum by means of absorption screens. The additive principle, the use of which appears to be novel, is based upon the discovery of a well-defined absorption band at about 260 mμ, in mica. A small variation in thickness of the mica screen produces a large variation in transmission in this spectral region relative to the rest of the spectrum in which the transmission remains practically constant.

The source of ultra-violet radiation was a quartz-mercury arc lamp. The test organism was *Bacterium coli communis* suspended in sterile distilled water. This suspension was atomised uniformly over the surface of a Petri dish, containing hardened sterile beef-peptone agar, and then exposed to ultra-violet radiation.

In the preliminary tests it was found that exposure of tne standard uninoeulated beef-peptons agar to ultra-violet radiation, of the intensities and for the time of exposure used in this investigation, had no effect upon the subsequently seeded surface. However, when using a very high radiation intensity, a subsequent seeding of the surface of the pre-exposed agar gave no growth, or only a small number of colonies of bacteria.

An investigation was made (1) of the spectral range of bactericidal action, (2) of the effect of varying the intensity of the exciting light, and 3) of the method of exposnre, whether continuous or intermittent.

From various experimental data it appears that germicidal action is produced by nltra-violet radiation throughout the spectral range extending from the very short wave lengths (Schumann rays) to and including 365 mμ. The shortest rays have the most violent lethal action, which decreases in intensity with increase in wave length.

The long wave-length limit of abiotic action is not well defined. Previous investigations have been interpreted as indicating that the long wave-length limit of abiotic action is in the region of about 297 mμ. In the present investigation, when the time of exposure was sufficiently prolonged, killing of bacteria was obtained through screens which transmitted ultra-violet radiation of wave lengths longer than 297 mμ, including the 365 mμ line. But no abiotic action was obtained through screens which transmitted only wave lengths longer than 365 mμ for the exposures used. The present tests, therefore, show that the long wave-length limit of ultra-violet action includes the wave length 365 mμ, and explains the bactericidal action obtained in sunlight.

The lethal action of radiation of wave lengths longer than 305 mμ was found very slow in comparison with radiation of wave lengths less than 280 mμ, even though the latter was much lower intensity. Using the ultra-violet radiation emanating from the quartz-mercury arc the lethal action of the wave lengths less than 280 mμ is estimated

to be at least 10 times more rapid than that of the wave lengths greater than 305 mμ.

Tests were made to determine the abiotic action of ultra-violet radiation when the total exposure is applied (1) continuously and (2) intermittently with short or long intervals of rest. No difference in the density of the growth of bacteria could be observed whatever the method of exposure. From this it appears that the intermittent exposure does not have a latent effect, either in stimulating growth or in continuing the lethal action ,during the intervals of rest, and that the killing effect is cumulative.

On low iutensities the killing action is greatly retarded; for example, using an intensity of $I \div 50$ it was necessary to expose the inoculated plate for 75 to 80 seconds instead of 50 seconds in order to secure the same killing effect as when using unit intensity and unit time. On still lower intensities there are some (although not thoroughly verified) indications of stimulation instead of lethal action.

It is shown that the energy value of the most active germicidal radiation from the quartz-mercury arc of wave lengths 170 to 280 mμ required to kill a bacterium is very small, being of the order of 19×10^{-12} watt or 4.5×10^{-12} g cal.

A further deduction is that, in order to produce a rapid abiotic action (in one second) the radiant flux of the germicidal radiation from the quartz-mercury arc must exceed a certain threshold value, which is of the order of 25 microwatts per square millimeter. This is obtained at a distance of about 15 cm (6 inches) from a 110-volt mercury in quartz arc lamp consuming about 320 watts (80 volts, 4 amperes) in the burner.

CORRESPONDENCE.

LAW OR HYPOTHESIS.

(*To the Editor of the* CHEMICAL NEWS.)

Sir,

I notice a growing tendency in elementary chemistry books to call Avogadro's famous Hypothesis, Avogadro's Law, which causes me to raise the question whether this hypothesis can be said ever to have been proved. The usual proof given from the kinetic theory of gases depends on the assumption that the mean kinetic energy of translation of all particles at the same temperature is equal. This again rests on Maxwell's theory of the equipartition of energy which, however consistent within itself is nevertheless a theory. Again, the fact that the gas laws in chemstry based on Avogadro's hypothesis always give results agreeing with practice, when carefully scrutinised, is found to be no proof at all, for we have assumed the hypothesis and then invented molecular states to agree with it, thus hydrogen is said to be H_2, and sulphur vapour anything up to S_8. The proof of the hydrogen molecule being H_2 is usually given as the hydrochloric acid experiment. Without Avogadro's hypothesis this proves nothing. Again Perrin's actual measurements of the Avogadro number " N " do not prove its real .existence, for he assumed Maxwell's theory as the basis of his proof.

It is possible we may have to some day revise all our gaseous chemical theory think the very consistency of the results obtained have blinded our eyes to the fact that in this we have done what Professor Eddington accuses the physicist so often of doing, *i.e.*, inventing a law which covers a concealed convention and then proving it true assuming the convention.

Yours faithfully,

W. R. C. COODE ADAMS,
Ph.D. (Cantab.).

38, Harcourt Terrace,
S.W.10.
December 14, 1925.

NOTICES OF BOOKS.

La Chimie des matieres colorantes organiques. By DR. P. CASTAN. Pp. IX + 456. Paris : Gaston Doin et Cie, Editeurs, 1926. Price 30 francs.

Most books dealing with colouring matter and dyes are written from a technical standpoint and it is therefore pleasing to note that Dr. Castan's volume of the series Encyclopedie Scientifique takes a more theoretical view of the subject.

Indeed the technical importance of a substance has been subordinated to the purely scientific interest, and in this way, compounds of little commercial value receive considerable attention on account of their theoretical importance.

The more important compounds of the

different types of dyes have been described in some detail, especially as regards their reactions and transformation into other derivatives. The natural colouring matters are also described, together with their syntheses.

The author has followed the usual practice as regards grouping. In accordance with French practice, the " contents " is placed at the end, together with a very limited bibliography, but a more comprehensive subject index is supplied.

FORTHCOMING EVENTS.

ROYAL SOCIETY .

Thursday, June 17, at 4.30 p.m.

Sir Arthur Schuster, F.R.S. " A Review of Mr. George W. Walker's Magnetic Survey (1915)."

Lord Rayleigh, F.R.S. " The Continuous Spectrum of Mercury Vapour in Relation to the Resonance Line 2536.52."

O. W. Richardson, F.R.S. " Structure in the Secondary Hydrogen Spectrum. IV."

W. L. Bragg, F.R.S., and J. West. " The Structure of Beryl, $Be_3\ Al_2\ Si_6\ O_{18}$."

A. P. Laurie. " On the Change of Refractive Index of Linseed Oil in the Process of Drying and its Effect on the Deterioration of Oil Paintings.' Communicated by Sir Arthur Schuster, F.R.S.

ROYAL SOCIETY OF ARTS.

Friday, June 11, at 4.30 p.m. (Indian Meeting.) Captain B. K. Featherstone, " Exploration in the Karakoram Mountains." Sir Francis E. Younghusband, K.C.S.I., K.C.I.E., D.Sc., LL.D., will preside.

MINERALOGICAL SOCIETY.

Tuesday, June 15, at 5.30 p.m.—Dr. F. L. Stillwell, " On the Nature of Berthierite." S. I. Tomkeieff, " On Some Chloritic Minerals Associated with the Basaltic Carboniferous Rocks of Derbyshire." H. E. Buckley, " The Anomalous Optical Properties of Several New Series of Isomorphous Double Tartrates." Dr. G. T. Prior, " On the South African Meteorites Vaalbult, Witklip, and Queens Mercy.

THE FARADAY SOCIETY.

The General Discussion on " Explosive Reactions in Gaseous Media," which was to have been held by the Society on May 18, will now take place on Monday, June 14, in the Hall of the Institution of Mechanical Engineers, Storey's Gate, Westminster, from 2.30 p.m. Copies of the programme, which remains unchanged, may be obtained on application to the Faraday Society.

THE PHYSICAL SOCIETY OF LONDON.

The next Meeting of the Society will be held on Friday, June 11, 1926, at the Imperial College of Science, Imperial Institute Road, South Kensington, S.W.7.

The following papers will be read :—

" The Latent Heat of Fusion of Some Metals." By J. H. Awbery, B.Sc., and Ezer Griffiths, D.Sc.

"The Piezo-Electric Quartz Resonator and its Equivalent Electric Circuit." By D. W. Dye, B.Sc.

" The Characteristics of Electrostatic Machines on Non-Inductive Loads and on the Coolidge Tube." By E. J. Evans.

New Patents.

These particulars of New Patents of interest to Readers have been selected from *the Official Journal of Patents, and are* published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

10,991.—Barbet, E. A.—Production of alcohol. April 26th.

11,331.—Davies, A. — Manufacture of chemical dispersion agents. April 29th.

11,331.—Davies, A. — Manufacture of chemical dispersion agents. April 29th.

10,914.—Drummond, A. A.—Synthetic resins. April 26th.

10,998.—Shepherdson, A.—Preparation of indanthrone disulphonic acids and indanthrone. April 26th.

Specifications Published.

251,310.—Neill, O. S.—Production of ferric oxide.

251,140.—Farbwerke vorm. Meister, Lucius & Bruning.—Manufacture of trisazo dyestuffs.
251,155.—Badische Anilin & Soda Fabrik. —Fabrik.—Drying cellulose esters.
251,188.—Naef Et Cie, M.—Process for the preparation of monocyclic ketones with more than nine ring members.
251,147.—Isajev, V.—Process for the production of bornyl esters from pinenes for the manufacture of camphor.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25 ,Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

248,874.—Anthraquinone derivatives. —Dodd, H., Sprent, W. C., & United Alkali Co., Ltd., Cunard Building, Liverpool.

Arylaminoanthraquinones. — The condensation of quinizarin with aromatic amines in presence of a condensing agent is effected in the presence of iron when the monoarylamino derivative is required, and in the presence of nickel or a nickel salt when the diarylamino derivative is required. According to examples mono- and di-*p*-chloranidido derivatives are obtained by heating a mixture of quinizarin, *p*-chloraniline, and boric acid in an iron and in a nickel vessel. The products yield wool dyes by sulphonation.

The Latest TRADE MARKS

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THE CHEMICAL NEWS.

VOL. CXXXII. No. 3453.

MERTON HOUSE, SALISBURY SQUARE,
LONDON, E.C.4.

TELEPHONES :
Administrative : Central 6521.
Printing Works : Hop 2404.

A COMPACT AND COMPREHENSIVE SERIES OF REACTIONS AND TABLES IN CHEMISTRY.

By ROBERT SAXON, B.Sc., F.C.S.

(*Continued from Page* 347.)

REDUCTIONS.

A great number of reductions are brought about by the fact that at high temperatures carbon monoxide is exceedingly stable, and of small density. Heat seems to lessen valency, and bring dyad oxygen, and tetrad carbon to the same power with regard to the bonds satisfied. To take away oxygen from oxides, by the help of heat, we must arrange the formation of a new oxide stable and light at high temperatures, and that oxide will most certainly be formed. We might also seek to bring about the formation of an oxide stable and heavy at a high temperature, and it has a good chance of forming.

The most important factors in the isolation of the elements from their compounds are :—

(a) The affinity of carbon for oxygen at high temperatures.

(b) That of the halogens for the alkali metals.

(c) The affinity of finely divided aluminium for oxygen.

(d) That of magnesium for oxygen or chlorine when heated.

(e) The pull that calcium oxide has for carbon dioxide, the latter being arranged for by heating oxides with carbon. This is a case of rapid removal, carbon dioxide being taken away by lime as soon as it is formed, adding its latent heat of vaporisation to help on the reaction, and getting out of the way of reversing such reaction.

(f) The electrochemical discharging power of electrodes, and consequent removal of affinity from one element for a different element.

Here are a few examples of reduction, where cohesion is made to assist in some cases, or the formation of a gas is compatible with heat.

i Na) NaCl (Cl, meaning that liquid sodium chloride is decomposed by the electric current, giving sodium at the cathode, and chlorine at the anode. Also Li, K, Rb, Cs, Ca, Sr, Ba, Mg, Zn, Cd, Al, Tl, Sn, Pb.

ii There is an *electrochemical series* of the elements, such that any member thereof displaces any other member coming after it in the series.

It is given differently by different people, because some elements displace one another impartially, according to conditions of temperature, etc. Where, however, two elements are far apart in such a list, it may be taken for granted that the prior one will displace the other. Thus, in the following, caesium will certainly displace manganese, and most certainly nickel or gold, but magnesium heated will displace the alkali metals from their chlorides. Here follows one list :—

Cs, Rb, K, Na, Li, Ba, Sr, Ca, Mg, Al, Cr, Mn, Zn, Cd, Fe, Co, Ni, Sn, Pb, H, Sb, Bi, As, Cu, Hg, Ag, Pd, Pt, Au, Ir, Rh, Os, Si, C, B, N, Se, P, S, I, Br, Cl, O, F.

This list is more electro than chemical, there being a greater voltage fall between well separated than near members of the list. Caesium is certainly the most electropositive, and fluorine the most electronegative element known.

iiA $Mg/ZnCl_2$ /mp $MgCl_2/Zn$

iii $Mg/FeCl_2$ /20d $MgCl_2/Fe$ (in solution)

iv $Zn/FeSO_4$ - $ZnSO_4/Fe$

v $Fe/CuSO_4$ - $FeSO_4/Cu$

vi $Cu/Hg(NO_3)_2/xHNO_3$ -
—.—.—.—.—.—.—

$Cu(NO_3)_2/Hg/xHNO$ (all sol-
—.—.—. —.—.
utes except the metals.)

vii $Hg/AuCl$ - $HgCl/Au$, etc.

There is a well-known reaction by the trade name of "Thermit," whereby aluminium, once started by heat, takes away oxygen from iron oxide, and in doing so develops an incandescence of heat that keeps the reaction going vigorously.

viii $.2Al/Fe_2O_3$ it/rt Al_2O_3/Fe (red heat starts the reaction, after which incandescent heat is kept up).

ix $4Al/3MnO_2$ it/rt $2Al_2O_3/3Mn$

x $2Al/Co_2O_3$ it/rt $Al_2O_3/2Co$

xi $2Al/3NiO$ it/rt $Al_3O_3/3Ni$

xii $2Al/B_2O_3$ it/rt $Al_2O_3/2B$

xiv $4Al/3TiO_2$ it/rt $2Al_2O_3/3Ti$

xv $8Al/3V_2O_4$ it/it $4Al_2O_4/6V$

xvi $2Al/MiO_3$ it/rt Al_2O_3/Mo

xvii $2Al/WO_3$it/rt Al_2O_3/W

As the dot preceding the 2Al in the first "Thermit" indicates, the aluminium must be finely divided in each case.

xviii $2NaCl/Mg$ -n/it $MgCl_2/2Na$.
. . .
Also K, Rb, Cs, Cu, Ag, Au, Ca, Sr, Ba, Zn, Cd, Hg, Al, Tl, Pb, Sn, As, Sb, Bi, Cr, Mo, W, U, Mn, Fe, Co, Ni, Pt.

Here the volatility of the metal displaced helps the reaction in the case of the alkalis and alkaline earths. In the other cases it is the more negative character of magnesium over the displaced metals. As far as K, Rb, Cs, Na, Li, Ca, Sr, Ba are concerned the action is reversible, and magnesium is prepared by distilling the chloride with sodium or potassium.

xix $BeCl_2/2Na$ n/it $2NaCl/Be$. Also Zn, Mg, Cd, Hg, B, Al, this group; groups iv., v., vi., vii., viii., Cu, Ag, Au.

xx $2Li/BeI_2$ n/350d $2LiI/Be$. Also iodides outside group i., and Cu, Ag, Au.

xxi BeI_2/Mg /450d MgI_2/Be BeI_2 Al, Ag, Cu, Hg O/mp (these do not reduce at melting point), 455d AgCl/alkali metals, group ii., Al, Pb, Sn, As, Sb, Bi, Fe /mp Ag/metal chloride. All these displace silver at the melting point, which is 455 degrees. AgCl /sl Ag/Cl. Silver chloride is reduced by sunlight. AgCl/ Nam O/.18d. Sodium amalgam does not reduce silver chloride. AgCl/S, C, O/.bp.

xxii $2AgCl.3NH_3/xNH_4OH/Cu_2S$ -
—.—.—.—.—.—.—.—

$CuS/CuCl_2$ /y $NH_4OH/2Ag$.

Silver chloride dissolves in ammonia, forming the given salt, from which cuprous sulphide precipitates silver. The cupric chloride forms a blue compound with ammonia referred to later.

xxiii 425d AgBr/Li etc., as for chloride /mp Ag/bromide

xxiv AgBr/H /rt HBr/Ag

xxv At 550d AgI/Li, etc., /mp Ag/iodide or metal and iodine

xxvi AgI/H /it Ag/H/I/.

This indicates that the action is incomplete. Where the mp of a chloride is high it is usual to take it in combination with some other chloride, the double salt having a lower melting point than the simple chloride.

xxvii $Na_2CO_3/.S/SaO$ /1090d - 98d 2Na883d/$CaO/CO_2/O$.

The carbon is finely divided, the reaction takes place at 1,000 degrees, sodium melts at 98, and boils at 883, therefore distils. The CaO will form some carbonate (not shown), but acts as a catalyst, probably by its power of forming a higher oxide.

xxviii $K_2CO_3/.C$ /800d $2CO_2/2K$

xxix ZnO/C /1200d ZnCO.

Zinc boils at 906d so some condenses as "blue powder" on walls to condenser. Also Cd hp. 778d., Cu, Hg, Sn, Pb, Co, Ni, as molten masses. Cadmium distils over.

xxx $B_2O_3/3K$ /brt $3K_2O/2B$

xxxi $KBF_4/3K$ /rt $4KF/B$

xxxii $K_3AlF_6/3K$ /rt $6KF/Al$

xxxiii $In_2O_3/6H$ /it $3HOH/2In$.

Electrolysis is the method now employed o isolate the metals of this group, though Al may be displaced from the sulphate by inc, and indium trioxide reduced by heat and hydrogen. 977d Na_3AlF_6, 2,000d Al_2O_3, 920d Al_2O_3/Na_3AlF_6 as 1 : 4, 940d Al_2O_3/Na_3AlF_6 as 1 : 6, $Al_2O_3/CaF_2/Na_3AlF_6$ as 18 : 23 : 59 melting at about 70d. Electrolysis gives—

xxxiv 2Al) 2Al : 30 : 6Na : $Al_2 6F_2$(C($3CO/2Na_3AlF_6$.

If the voltage is low enough the carbon electrode is wholly occupied with the oxygen, and cryolite is unaffected therehy. In addition, the cathode cannot tear away the sodium, an example of the superior tenacity of fluorine. Higher voltage, however, takes the "sceptre" from that element.

xxxv 2In) 2In : $3SO_4$: 6H : 6OH (6OH - 3HOH/30, also Tl. Here sulphuric acid is produced continuously, as water diminishes.

xxxvi 2Ga) 2Ga : $3SO_4$: 6H : 6OH : 6K : 6OH (3HOH/30, or more probably
2Ga) 2Ga : $3SO_4$: 6K : 6OH : 6H : 6OH (3HOH/30, but the relative proportions of KOH and HOH determine which way the reaction goes. Reducing agents which do not set up opposition to the current as hydroxylamine assist the reaction.

xxxviA 2In) 2In :6Cl : 6H : 6OH (3HOH/30.

As the amount of HCl increases, chlorine will be liberated.

xxxvii 2Ga) 2Ga : 30 : xK : xOH : xH : xCl (xCl.

The melting and boiling points of a few metals and chlorides, etc., of the aluminium group shows how it is easy to get the metal by electrolysis of the molten halide—2250d B (?), -127d BF_3 -101d, -107d BCl_3 12.5d, - 46d BBr_3 90.5d, 43d BI_3 210d, compare 557d B_2O_3, 185d H_3BO_3, 658d Al 1800d, 1100d AlF_3 1100d (sublimes at 1100) useless for electrolysis, 179d $AlCl_3$ 200 to 500d not suitable owing to loss in subliming, 93d $AlBr_3$ 263d much better, 125d AlI_3 350d, 1000d Na_3AlF_6 too near the bp. of Al, $2Na_3AlF_6/3CaF$ /little NaCl melts at 700, 30.15d Ga (?), 75.5d $GaCl_2$ 220d, 378d Ga_2Cl_6, bromide less fusible, 155d In rt, 600d $InCl_3$ 600d useless, 351d InI 700d, 200 InI_2 xx (decomposes), 625d Ce(?), 848d $CeCl_3$, 810d La , 907d $LaCl_3$?, 940d Pr ?, 818d $PrCl_3$, 840d Nd ?, 785d $NdCl_3$?, 1400d Sm?, 685d $SmCl_3$?, 300d Tl 1300d, 451d TlCl 730d.

The last metal does not show much relationship to the other metals of its group. It is softer than lead, whereas samarium is as hard as steel. Thallium is in the nature of a "*keystone*" element, bridging two groups, the third and the first. Lithium, beryllium, boron, gold, mercury, lead, bismuth, thorium, and uranium, are among such.

It is in this group that hydrogen begins to figure as a reducing agent, for with the exception of copper, silver, gold, and mercury, nothing is heard of that element as a reducing factor. Oxides are reduced to the metal in a great number of atomic weight determinations, which will be dealt with later.

xxxviii $Ga_2O_3/6H$ /brt $2Ga/3HOH$, also others in group iii.

xxxix Al_2O_3/xCl or xH /it /O (no action).

xl $CF_4/4H$ /rt $C/4HF$, also chloride, bromide, iodide, with formation of methane (CH_4), ethane (C_2H_6), ethylene (C_2H_4) etc., also SiF_4, $SiCl_4/4H$ /rt $Si/4HCl$, also bromide and iodide.

xli $CF_4/4K$ /rt $4KF/C$, also chloride, etc., with alkali metals, also silicon compounds.

xlii $CF_4/2Mg$ /rt $2MgF_2/C$, also as before with also Ca, Sr, Ba.

xliii $K_2SiF_6/4K$ /rt $6KF/Si$, also corresponding compounds of Ti, Zr, Sn, Pb, Th, Ru, etc., double haloid salts.

xliv C_2Cl_6, C_2Cl_4, C_6Cl_6 reduced in the same way with the greatest difficulty.

xlv $CO_2/2Mg$ /it $2MgO/C$, also SiO_2, $TiO_2/2Ca$ /it $2CaO/Ti$, also corresponding oxides of this group, also by carbon at " et," also by Mg or $MgCe_x$ at "it."

xlvi $SiO_2/2CSi$ /2500d $4Si/2CO$, also other dioxides and by $.FeC_x$

xlvi $SiO_2/2CSi$ /2500d $4Si/2CO$, also other dioxides and by $.FeC_x$

xlvii $GeO_2/2C$ /et $Ge/2CO$, " et " referring to the electric furnace, as " it " refers to incandescent heat

xlviii $TiCl_4/2Mg$ /it $2MgCl_2/Ti$. Note that Mg reduces most chlorides on heating, even the haloid salts

xlix $TiCl_4/4Na$ /it $4NaCl/Ti$, also $ZrCl_4$, $ThCl_4$ tin and lead are easily reduced by any of these methods, the usual reducing agent for tin being anthracite.

l $SnO_2/2C/xCaO$ /brt $Sn/xCaO/2CO$. Lead is found generally as the sulphide, and this partially roasted uses sulphide to reduce oxide and sulphate

li $PbS/3\ O$ /rt PbO/SO_2 $PbS/4O$ /rt $PbSO_4$, $PbS/PbSO_4$ /it $Pb/2SO_2$ (lead boils at 1470d)

lii $2PbO/PbS$ /brt $3Pb/SO_2$ (bright red heat)

liii $2PbO/C$ rtxx $2Pb/CO_2$ (readily reduced at red heat)

EAST AND WEST (REDUCTION).

It will be found that all reducing agents are found " west " of the line between carbon and nitrogen, that is, in the first four groups. We should never think of employing members of the other groups to reduce compounds, even though they show great affinity for oxygen as phosphorus, vanadium, etc. In the " eastern " groups we come across the region of non-metals. Affinity for oxygen, fluorine and chlorine increases considerably as we approach the west and descend the table. The " north-east " corner of the periodic table whose " foundation stone " is fluorine, is decidedly non-metallic and electrochemically negative, while the south-west " corner, whose champion is caesium, is decidedly metallic and positive. Between the two extremes, we find irregularities of streak and relationship well in keeping with the fascinating, though somewhat tantalising " exceptions " to all nature's and man's laws. Let us continue our examples of reduction :—

liv NH_4NO_3 /t $2HOH/NON$, NH_4NO_2 /t $2HOH/2N$, KNO_2NH_4Cl /t $KCl/2HOH/2N$

lv $2NH_3$ /6Cl - $6HCl/2N$ (strong solution), $8NH_3/6Cl$ - $6NH_4Cl/2N$

lvi $4NH_4NO_3/2NH_4Cl$ /t $10N/2Cl/2HOH$ (solids heated.

These are really cases of oxidation of the hydrogen linked to nitrogen in ammonia as with potassium bichromate and ammonium chloride or sal-ammoniac—$2NH_4Cl/K_2Cr_2O_7$ /wt $Cr_2O_3/2KCl/4HOH/2N$

lvii $(NH_4)_2Cr_2O_7$ /t $4HOH/Cr_2O_3/2N$. Here is a salt which contains sufficient hydrogen to reduce the acid oxygen.

lxviii $2HNO_3/10H$ - $6HOH/2N$

lxix $N_2O_5/10Na$ /wt $5Na_2O/2N$, etc., $N_2O_5/5Mg$ /mp $5MgO/2N$ (dropped in). Note 30d N_2O_5 44d, and 750d Mg, also H, Na, or Mg, Ca, Sr, Ba, reduce—10d N_2O_4 22d N_2O_3, NO, and N_2O. NO_2 exists only above 100d.

lxx $NO/5H$ /t Pt bk HOH/NH_3 (platinum black)

lxxi $5NO/2P$ /t $P_2O_5/5N$, also other oxides more easily

lxxii $2KNO_3/5H_2SO_4/6FeSO_4$ /t $2KHSO_4/3Fe_2(SO_4)_3/4HOH/2NO$ all solutes, $FeSO_4$ is a good reducing agent

lxxiii $3Cu/8HNO/xHOH$ /15d $3Cu(NO_3)_2/4HOH/2NO/xAq$

lxxiv $4Cu/8HNO$ /t $3Cu(NO_3)_2/CuO/N_2O$

lxxv $5Cu/8HNO_3$ /150d $3Cu(NO_3)_2$ $2CuO/2N$

lxxvi $5Zn/12HNO_3$ /wt $5Zn(NO_3)_2/2N$

lxxvii $4Zn/9HNO_3$ /t $4Zn(NO_3)_2/3HOH/NH_3$

lxxviii P_4O_6 /6C /et $6CO/4P$

lxxix $P_2O_5/5C$ /et $5CO/2P$, also P_2O_4, P_2O, and P_4O

lxxx $Ca_3(PO_4)_2/3SiO_2/5C$ /1400d $3CaSiO_3/5CO/2P$. The object aimed at in reductions is to produce a flux such as this calcium silicate.

lxxxi $2AlPO_4/3SiO_2/3C$ /1400d $Al_2(SiO_3)_3/5CO/2P$

lxxxii $Ca_3(PO_4)_2/3H_2SO_4/xHOH$ /bp .... $3CaSO_4/2H_3PO_4/xHOH$, H_3 .... PO_4 /rt HPO_3/HOH, $2HPO_3/6C$ /it $6CO/2H/2P$

lxxxiii $5Mg/P_2O_5$ /it $5MgO/2P$

lxxxiv $10Al/3P_2O_5$ /it $5Al_2O_3/6P$, also other reducing metals with production of phosphides in some cases.

lxxxv $3Ca(PO_3)_2/10C$ /brt $Ca_3(PO_4)_2/10CO/4P$

lxxxvi Phosphides of metals like sodium, magnesium, boron, aluminium, manganese are powerful reducing agents at high temperatures

lxxxvii The oxides of arsenic are reduced in exactly the same way as those of phosphorus, as also are those of antimony and bismuth

lxxxviii $FeAs_2.FeS_2$ /rt $2FeS/2As$

lxxxix $2AsF_3/3Zn/3H_2SO_4/xHOH$ /rt $3ZnSO_4/6HF/2As/xHOH$, any other compound of arsenic

xc $As_2O_3/6Zn/6H_2SO_4$ - $6ZnSO_4/3HOH/2AsH_3$

xci The halogen salts of all elements in this and the sixth, seventh, and eighth groups are reduced by the alkali and alkaline earth metals and magnesium

xcii $Sb_2S_3/3Fe$ /650d $3FeS/2Sb$

xciii $2SbCl_3/xHCl/3Zn$ /t $3ZnCl_2/2Sb/xHCl$ (few drops of HCl)

xciv 6H) 6H : 6(OH) : 6Na : $2(SbS_4)$ ($Sb_2S_5/3S$, $3Na_2S/Sb_2S_5/$ /xHOH - $2Na_3SbS_4/xHOH$

Hence the production of S in the electrolysis of antimony pentasulphite dissolved in sodium sulphide, and the reformation of the Na_3SbS_4, also 2Sb) 2Sb : 5S : 10Na : 10(OH) (5HOH/5 O, hence the production of oxygen which oxidises sodium sulphide to sulphate; any sodium sulphite being produced will reduce polysulphides to produce the thiosulphate.

xcv $3HOH/2Sb$ 150d $Sb_2O_3/6H$

xcvi $2KSbO_3/H_2SO_4/Zn$ /t $K_2SO_4/ZnO/HOH/Sb_2O_4$

xcvii $2KSbO_3/3H_2SO_4/2Zn$ /rt $K_2SO_4/2ZnSO_4/3HOH/Sb_2O_3$

xcviii $Bi_2S_3/9$ O /rt $3CO/2Bi$, $Bi_2O_3/2Fe$ /t $Fe_2O_3/2Bi$, Bi_2O_3/CaC_2 /t $CaO/2CO/2Bi$

xcix $Bi(NO_3)_3/3Na$ - $3NaNO_3/Bi$

c $Bi_2(SO_4)_3/2Al$ - $Al_2(SO_4)_3/2Bi$

ci $2Bi_2(SO_4)_3/6Zn$ - $6ZnSO_4/4Bi$

cii $2BiOCl/3Mg$ /rt $2MgO/MgCl_2/2Bi$

ciii $Bi_2O_3/2Al$ /rt $Al_2O_3/2Bi$

civ Bi_2O_5/C /rt Bi_2O_3/CO_2

cv $Bi_2O_5/3H_2SO_4$ /t $Bi_2(So_4)$ 3/2O

cvi Same /it $Bi_2O_3/3SO_2/3HOH/5$ O

cvii $BiCl_3/3Na$ /250d $3NaCl/Bi$

cviii $V_2O_5/5C$ /et $5CO/2V$

cix $V_2O_5/H2SO_4/xHOH/Fe$ - $FeSO_4/HOH/V_2O_4/xHOH$

cxii $V_2O_5/3H_2SO_4/xHOH/3Zn$ - $3ZnSO_4/3HOH/V_2O_2/xHOH$, also usual "oxyhungry metals"

cxiii $V_2O_5/2Al$ /rt $Al_2O_3/O_2/2V$, the heat engendered drives off the oxygen from fresh pentoxide before lower oxides are reduced, hence the amount of aluminium is less than that required to reduce wholly the pentoxide

cxiv $2KVO_3/2Al$ /rt $2KAlO_2/2VO$

cxv $VOCl_3/5H$ /it $3HCl$ /HOH/V

cxvi 2V)Fe) 2V : 6F ($V_2O_3/3C$($2VF_3/3CO$.

Note the meaning of this notation. Molten vanadium fluoride is broken up by electrolysis. Vanadium is delivered at the iron cathode. Fuorine is liberated at the anode consisting of a mixture of carbon and vanadium trioxide. The fluorine reacts with this mixture to give fresh vanadium fluoride, and carbon monoxide.

cxvii $CbCl_5/5H$ /rt $5HCl/Cb$

cxviii $Cb_2O_5/5C$ /et $5CO/2Cb$

cxix Cb_2O_5/La Ce /it 2Cb/oxides

cxx $2CbCl_5/5HOH$ /t $10HCl/Cb_2O_5$

cxxi $2CbOCl_3/3HOH$ /t $6HCl/Cb_2O_5$

cxxii $2CbCl_5/6HOH$ /t $10HCl/2HCbO_3$

cxxiii $2CbOCl_3/4HOH$ /t $6HCl/2HCbO_3$

cxxiv $2HCbO_3/3HOH/Zn$ /t $Zn(OH)_2/Cb_2O_4 3HOH$

cxxv $K_2TaF_7/5Na$ /it $2KF/5NaF/Ta$

cxxvi (vac(Ta_2O_4 /et $2Ta/4O$)), meaning "by means of the electric furnace in vacuo."

Sulphur is found native and needs no reduction. It is easily removed from its associates in compounds. All the reducing agents hitherto met with, especially in the earlier groups, take away oxygen readily from sulphur oxides.

cxxvii FeS/H_2SO_4/t $FeSO_4/H_2S$

cxxviii $H_2S/2Cl$ - $2HCl/S$

cxxix $SO_2/2Mg$ /rt $2MgO/S$

cxxx $FeSO_4/2S$ /rt $FeS/2SO_2$

cxxxi $2FeS/3HOH$ /t $Fe_2O_3/6H/2S$

cxxxii CaS_5/HOH /rt $CaO/H_2S/4S$

cxxxiii $2S_2Cl_2/3HOH$ /18d $H_2S_2O_3/4HCl/2S$ (note that instead of /18d meaning at 18 degrees z centigrade, we might have put the dash -)

cxxxiv $H_2S_2O_3$ - H_2SO_3/S

cxxxv H_2S_2 /xHOH - $H_2S/S/xHOH$.

Sulphur is a very weak anion, and it is difficult to prevent it leaving its ion during electrolysis. Selenium and tellurium are also weak anions. It is remarkable, however, how compactly and tenaciously they *lie with heavy metals to form opaque sul*phides, selenides or tellurides, in decreasing order of tenacity. Heat alone will decompose selenides and tellurides more easily than sulphides. Even a compound like barium sulphate or selenate may be reduced by heating with carbon to the sulphide or selenide, from which by sulphuric acid or steam, hydrogen sulphide or selenide may be obtained easily decomposable. The remaining elements of this group, namely, chromium, molybdenum, tungsten, and uranium, have a much fiercer affinity for oxygen than the three foregoing, but they yield to reducing agents like their predecessors.

cxxxvi $Cr_2O_3/3C$ /et $3CO/2Cr$

cxxxvii $Cr_2O_3/2Al$ /it $Al_2O_3/2Cr$.

This process is called the Goldschmidt Process, where the heat produced by the combustion of the finely divided aluminium is sufficient to decompose the oxide and melt the resultant metal. Granulated aluminium is used, and a fuse powder of barium peroxide and aluminium is used to start the reaction. Great heat is necessary *to start, but intense heat is given out once* started. $3BaO_2/2Al$ 360/1500d $Al_2O_3/3BaO$. This indicates that a temperature of 1500 degrees centigrade is necessary to start the reaction and that 360 big calories, or as we express it 360/ results from the burning of the aluminium, and the breaking

up of the peroxide, the latter requiring heat. A remarkable fact obtains which might explain *catalytic action*. In order to assist reduction a higher oxide is mixed with the above in the form of a bichromate or permangate. This by providing oxygen assists the oxidation of the aluminium and the heat thereof, acting as an *internal combustion furnace*. At the same time it should be observed that there is released the base from the permanganate or bichromate which tends to form a flux with the alumina in the cooler parts and assist in its removal.

cxxxviii Cr_2O_3/3C /1200d 3CO/2Cr, and % 3Cr/2C /1200d Cr_3C_2. (% means part reaction.)

cxxxix $3Cr_3C_2$/2CaO /1200d 2CO/. $2CaC_2$/9Cr

cxl $2Cr_2O_3$/3Si /1600d $3SiO_2$/4Cr.

Note that c.1505d Cr, and c.1780d SiO_2 (they melt about these temperatures.)

cxli $2Cr_2O_3$/Sb_2S_3 /rt $3SO_2$/2Sb/4Cr.

Note Sb 1440d, therefore at 1500d the antimony would distil over, and this is one of the controlling factors in the reaction.

cxlii $CrCl_3$ /3K /1000d 3KCl/Cr

cxliii $2CrCl_3$/3Zn /750d $3ZnCl_2$/2Cr.

Note $CrCl_3$ 1300d, $ZnCl_2$ 730d, and 770d KCl, so that a temperature above 1300d or below 770d would not suit the first, and one above 730d distils away the zinc chloride.

cxliv MoO_3/2H /800d 2HOH/MoO_2

cxlv MoO_2/2C /it 2CO/Mo

cxlvi Molybdates yield in the same way especially in the presence of lime.

(To be Continued.)

General Notes.

INTERNATIONAL COMBUSTION, LTD.

International Combustion, Limited, of Africa House, Kingsway, W.C.2., have informed us that their associated company in America have recently received a number of contracts for Lopulco Pulverised Fuel Equipment for U.S.A. Railways, Power, and other installations.

BOARD OF TRADE ANNOUNCEMENT.

COMMITTEE ON DATING AND SEALING PATENTS.

The Board of Trade have appointed a Committee consisting of Mr. J. Whitehead, K.C. (chairman), Mr. H. A. Gill, M.A., Mr. A. J. Martin, O.B.E., Major-General Sir Philip Nash, K.C.M.G., C.B., and Mr. J. Swinburne, M.Inst. C.E., F.R.S., to enquire into and report whether any, and if so, what change is desirable in the practice of the United Kingdom of (a) dating and sealing patents applied for under Section 91 of the Patents Acts, 1907 and 1919, as of the date of the application in the foreign State; (b) dating and sealing other patents as of the date of application, as provided by Section 13 of the Acts.

The Secretary to the Committee is Mr. B. G. Crewe, the Patent Office, 25, Southampton Buildings, London, W.C.2., to whom all communications relating to the work of the Committee should be addressed.

THE INSTITUTE OF PHYSICS.

EXAMINATION FOR THE ASSOCIATESHIP, 1926.

The Institute will hold its Examination of Candidates for the Associateship in London at the end of September, 1926. Applications for entry must be received before June 30.

Forms of application and copies of the papers previously set can be obtained from the Secretary, The Institute of Physics, 90, Great Russell Street, London, W.C.1.

Regulations for admission into the Institute without examination will also be sent on application.

BERYLLIUM IN CANADA.

Canadian occurrences of beryl, the aluminium silicate of beryllium, have hitherto been regarded as primarily of mineralogical interest or as possible sources of emerald, but a new use for the metal beryllium (or glucinum) as a constituent of special light weight alloys has recently directed attention to the economic value of these occurrences. One of the richest deposits known in Canada is situated in Renfrew county, Ontario, about 150 miles north-east of Toronto, and near the village of Quadville.

The pure, deep green, transparent forms of beryl are in great demand as gem stones. Ordinary beryl is sometimes used to re-

place feldspar in the manufacture of porcelain for use in the higher grades of spark plugs and insulators; a more universal recognition of this use alone would probably require a considerable quantity of the mineral.

1926 CONVENTION OF THE ILLUMINATING ENGINEERING SOCIETY.

The twentieth annual Convention of the Illuminating Engineering Society will be held at Spring Lake, N.J., U.S.A., from September 7 to 10 inclusive, with headquarters at the Essex and Sussex Hotel.

A comprehensive programme of papers is being prepared with special features showing the developments in specific fields which have taken place during the twenty years of the Society's existence.

BOARD OF TRADE ANNOUNCEMENT.

The following statement relating to applications for licences under the Dyestuffs Import Regulation) Act, 1920, made during May, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 401, of which 369 were from merchants or importers. To these should be added 17 cases outstanding on the 30th April, making a total for the month of 418. These were dealt with as follows :—

Granted—370 (of which 357 were dealt with within 7 days of receipt).

Referred to British makers of similar products—39 (of which 28 were dealt with within 7 days of receipt).

Referred to Reparation Supplies available—4 (all dealt with within 7 days of receipt).

Outstanding on 31st May, 1925—5.

Of the total of 418 applications received, 389, or 91 per cent., were dealt with within 7 days of receipt.

MINING IN BRITISH COLUMBIA.

The mining industry of British Columbia is on a better financial footing than it has been hitherto. Last year's production of $61,500,000 exceeds that of any previous year and the dividends paid amounted to over $6,000,000, or about 10 per cent. of the production. The profits came chiefly from metal mining and particularly from lead ,zinc, silver and gold. A keen interest is being taken in the mining industry, and an unusually large number of engineers, backed by ample capital, are conducting a lively search for workable deposits, which work has been expedited by an early spring.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

Papers read on Thursday, March 18.

On the Electrostatic Potential Energy, and the Rhombohedral Angle of Carbonate and Nitrate Crystals of the Calcite Type. By S. Chapman, F.R.S., J. Topping, and J. Morrall.

A calculation of the electrostatic potential energy of ionic lattices of the calcite type has been made, together with a similar calculation for the sodium nitrate crystal; for in the latter case the lattice is of the same geometrical type, but the ionic changes are different.

On certain natural assumptions, the rhombohedral angle has been calculated for the calcite series of carbonates, and a theoretical explanation of the small change in rhombohedral angle from one member of the series to another is given.

The interpretation of the results is not without some ambiguity. However, it seems probable that, owing to the fourfold positive change in the C ions, the O ions of the CO_3 group will be distorted from their natural symmetrical form, and consequently the electrostatic centre of the O ion will be nearer to the C nucleus than the O nucleus is. The results of these calculations indicate that the electrostatic centre of the O ion is 0.9 A distant from the centre of the Cion, compared with the value 1.25 A given by X-ray measurements for the distance between the O and C nuclei. A similar result is obtained for $NaNO_3$.

Gaseous Combustion in Electric Discharges. Part I. By G. I. Finch and L. G. Cowen. Communicated by Prof. W. A. Bone, F.R.S.

Steady direct current electric discharges are passed through electrolytic gas at 20 to 100 mm. pressures and the rate of steam formation measured for varying conditions

of current, gas pressure, and degree of separation of electrodes. It is shown that—

(i) Rate of combustion is determined only by current.

(ii) Up to a certain limiting current which depends upon material of cathode, gas pressure, and separation of electrodes, combustion is confined to cathode zone.

(iii) Such cathodic combustion is independent of potential fall between, and of separation of, electrodes, gas pressure, and temperature of discharge, but depends upon cathode material.

(iv) Rate of such cathodic combustion is directly proportional to current.

(v) On exceeding a certain limiting current, combustion commences *abruptly* in inter-electrode zone and is superposed, as a simultaneous effect, upon cathodic combustion.

(vi) This inter-electrodic combustion is also proportional to current; unlike the cathodic, however, it is independent of material of electrodes, but dependent upon gas pressure and separation of the electrodes, but dependent upon gas pressure and separation of the electrodes.

(vii) Little or no combustion takes place in the anode zone.

From these facts it may be concluded that the combustion was primarily determined by ionisation of gaseous medium through which current passed. The abrupt superposition of inter-electrodic upon cathodic combustion is suggestive of a quantum effect, combustion in the inter-electrode depending upon a certain limiting potential fall being attained.

A Homogeneous Unimolecular Reaction—the Thermal Decomposition of Acetone in the Gaseous State. By C. N. Hinshelwood and W. K. Hutchinson. Communicated by Prof. J. W. Nicholson, F.R.S.

The thermal decomposition of acetone vapour is a homogeneous unimolecular reaction, and has been investigated over the temperature range 506° to 632° C.

The heat of activation is 68,500 calories, and the results can be summarised by the equation—

$$l_n k = 34.95 - \frac{68,500}{RT}.$$

Calculation shows that the number of molecules reacting per second is about 10^5 times greater than the maximum number that could be activated by collision.

The absolute rate at 885° Abs. is the same as that of the nitrogen pentoxide decomposition at 328° Abs., the value of E/RT being nearly the same in the two reactions for these two temperatures.

The Theory of Ship Waves. By E. T. Hanson. Communicated by F. E. Smith, F.R.S.

The oscillations of a fluid under gravity, when the depth is uniform or very great, have been worked out in considerable detail. When the depth is variable the problem is difficult; but, in two special cases, solutions, confined to particular modes of oscillation, have been obtained. In this paper the theory is extended very generally to cover a series of cases in which the fluid may be treated as a sea, bounded by a sloping shore on one side, while extending indefinitely on the other. It is shown that, whenever the inclination of the shore to the horizontal is a submultiple of a right angle, the problem can be completely solved, and that, moreover, in each case there is a doubly infinite number of possible modes of motion under gravity.

This extension makes it possible to calculate the precise effect of a sloping shore upon the formation of the beautiful wave pattern, which is often observed to follow in the wake of a ship. The modified wave pattern is considered in detail, when the inclination of the shore is 45° and when it is 30°, the ship being assumed to move in a direction parallel to the shore. The difference between the two cases is considerable. One of the results obtained is that the wave pattern is practically confined within two lines radiating from the ship and making angles with the direction of motion of precisely the same magnitude as those pertaining to the case of infinite depth. In this respect, therefore, there is marked difference from the problem of finite depth.

Some points in the theory of ship waves on a sea of uniform finite depth, and the associated theory of the waves at the surface of separation of two fluids of different density, are also treated.

ROYAL INSTITUTION.

A general meeting of the Members of the Royal Institution was held on June 7. Sir Arthur Keith, Treasurer and Vice-President, was in the chair.

The Chairman announced that the President had nominated Sir James Crichton-

Browne, Dr. J .Mitchell Bruce, Sir Ernest Moon, Sir Edward Pollick, Sir Almroth Wright, Sir Alfred Yarrow and Sir Arthur Keith, Treasnrer and Sir Robert Robertson, Secretary, as Vice-Presidents for the ensuing year.

Mr. W. H. Inskip, Mrs. James Mitchell, Dr. Boris Orelkin, Dr. H. R. Rice and Dr. J. F. Tocher were elected Members.

ROYAL MICROSCOPICAL SOCIETY.

THE PRESIDENT'S ADDRESS.

January 20, 1926.

The Fungi Imperfecti, and a Further Plea for an Institute of Industrial Micro-Biology. By A. CHASTON CHAPMAN, F.R.S, F.I.C., F.R.M.S.

The scientific classification of a group of organisms so large and containing so many intermediate or "transitional" members as that of the Fungi is obviously attended with very serious difficulties, and numerous attempts in this direction have been made from time to time. In most of the schemes which have been put forward it is customary to divide the *mycomycetes*, which are characterised by the formation of *septate mycelium*, into two main groups, the *ascomycetes*, which includes the yeasts with which I dealt in my address last year, and a group known usually as the *Fungi Imperfecti*. This latter group includes a number of organisms which differ very considerably from one another, and which are so classed together chiefly because our knowledge is not at present sufficient to permit of more definite positions being assigned to them. Among the better known of this group are *torula*, *mycoderma*, *monilia*, *charlara*, *endomyces* and *ooidium*.

Although the systematic mycologist may not regard this classification as altogether beyond criticism, it has an advantage from my own point of view this evening. You may remember that in my address last year I dealt with another large and much better defined group of the lower fungi, namely, the *Saccharomycetes* or Yeasts. On that occasion I called attention to the fact that whilst a number of the yeasts are definitely cultivated for industrial purposes, others occur wild in nature, and are known to be industrially pathogenetic. In the case of the *Fungi Imperfecti* to which I propose to refer this evening, the majority are intrusive organisms of an undesirable character from the manufacturers point of view, but in not a few cases are they known to be productive of useful and beneficial results.

Perhaps the most important, and in some respects the most interesting, organisms included among the *Fungi Imperfecti* are the torulæ. The word *torula*, at one time regarded as more or less synonymous with *saccharomyces*, and used to designate the ordinary yeasts, has, since the classical investigations of Hansen, been restricted to those unicellular budding fungi which, unlike the true yeasts, are apparently incapable of forming ascospores. That they are in some way related genetically to the Saccharomycetes can scarcely be doubted; but the nature of the relationship is very obscure, and it would carry me beyond the limits of this address to deal with any of the views which have been put forward. In the case of a group of organisms in which morphological and physiological differences are often so slight, there are many possibilities of error, and there can be very little doubt but that in many cases one and the same organism has been described as new by different workers, and has passed into the literature of the subject under different names. As I have indicated above, the torulæ are unicellular, non-sporing, budding fungi. As a rule they are spherical, but occasionally they are ellipsoidal and elongated ,and almost invariably smaller than the cultivated yeasts. They occur very widely spread in nature, and many of them are of some industrial significance. Colourless as a general rule, some produce a red pigment, which I have shown to be closely related to carrotene, whilst one or two are black. In a few species, sometimes referred to as the *mycotorulæ*, there is a tendency to the formation of mycelium, or rather to the production of greatly elongated cells. They are of frequent occurrence in breweries, dairies, sugar factories, oil refineries, and other food factories, and are met with in the air, in the soil, in the secretion of trees, and in the intestinal tract of animals.

As compared with the Saccharomycetes their fermentative activities are feeble, but like the yeasts, they differ considerably in respect of the enzymes they secrete, and consequently of the sugars they are able to ferment. In some cases only dextrose and fructose are fermented, whilst other species

are able to ferment a considerable variety of carbohydrates, including cane sugar, maltose, mannose, lactose, galactose, and even raffinose and arabinose.

In breweries these organisms are not often a source of serious trouble, since owing to their lower fermentative activities they are easily kept in check by the more vigorously fermenting yeasts. One or two species, however, have been credited with the production of unpleasant flavours and turbidity, whilst others may apparently give rise to "ropiness" or "slime" in liquids of low alcoholic strength. On the other hand, it has been shown that some of these torulæ serve a useful purpose, and in 1905 Claussen described a small group of organisms to which he assigned the name *Torula Brettanomyces*, and which are frequently associated with the conditioning of English bottled beers. A few years later these organisms were more closely investigated by Schiönning, who showed that they could be referred to two distinct groups, both of which are capable of bringing about a slow and lasting fermentation in beer, and in the case of beer in bottle of giving a considerable amount of gas, a stable head and a characteristic flavour and aroma, due to the reaction of the acid formed as a result of their activity, with the alcohol present in the beer.

In the cider industry, again, torulæ appear to play a not unimportant part, and especially in connection with the conditioning of bottled cider, since out of thirteen yeast-like organisms isolated from bottled ciders by Pearce and Barker, no less than five torulæ were found in apparently active condition.

Having regard to the well-established fact that some of the torulæ are known to be pathogenic to man and other animals, their presence in milk may have a more serious significance than is usually assigned to it. There is, in fact, some evidence to show that gastric disturbances have at times been caused by torulæ present in milk, and a considerable number of species have been described which are more or less virulently pathogenic to the lower animals, and some of them probably to man.

In the case of condensed milk, again, the presence of these organisms is frequently a source of considerable trouble to the manufacturer, since they are capable of developing, though slowly, even in very strong sugar solutions, with the production of carbon dioxide gas, alcohol, acidity and other products. Thus, some species will develop apparently without difficulty in sweetened condensed milk containing as much as 43 per cent. of cane sugar in addition to 18 per cent. of milk sugar, and only 24 per cent. of water. This results in the blowing of tins, and is at times a source of very considerable loss to the makers of condensed milk. In the course of my own experience, extending over a good many years, I have only found the production of gas in condensed milk to be due to any other than torulaceous organisms in a very small percentage of cases. On the other hand, some species of torulæ have a limited sphere of usefulness in the production—in symbiotic connection with certain bacteria—of fermented milk beverages largely consumed in the East, such as Kephir, Koumiss, Mazun and others.

From cheese a certain number of torulaceous organisms have at various times been isolated, but whether they serve any useful function, or are to be regarded as inert or injurious, does not appear to be known with certainty. On the surface of hard cheese torulæ are occasionally met with, liquefying the casein, giving rise to the production of gas, and causing, in consequence, a blistered appearance. I have also met with them on the surface of bacon, and in many other foodstuffs.

In butter torulæ are also sometimes present, as well as in some badly refined vegetable oils, and as they occasionally contain a lipolytic enzyme and produce fatty and other acids, they are very apt to give rise to pronounced rancidity.

In raw sugars torulæ are frequently abundant, their activity being of an essentially destructive character.

Among the more interesting members of this group of organisms must be mentioned those species or varieties which can grow in strong salt solutions. Several of these have been isolated, and are found to be capable of developing in nutrient media containing as much as 30 per cent. or even 35 per cent. of common salt. These have been found at times to occur in pickled fish, and are said to have produced trimethylamine and other unpleasantly smelling compounds. Torulæ have even been isolated from sea-water.

A second important group of the *Fungi Imperfecti* includes the various species of *mycoderma*. This consists of organisms

which develop in contact with air, and which are frequently found in the form of a greyish, wrinkled, and often greasy film on the surfaces of beer, wine or other alcoholic liquids which have been exposed for some time to the air. Morphologically they consist of rounded or elongated cells, the shape of which varies very greatly, even in one and the same species. When young they are found to be more or less rounded, whilst in older films they become much more or less elongated, their diameter diminishes, and they present a shrivelled appearance. The younger and more vigorous cells are characterised by the presence of a number of highly refractive granules and fat globules. They reproduce by budding, and do not form spores. By some authors these organisms have been described as non-sporing forms of the *pichia* and *willia* groups of the Saccharomycetes, the members of which also form films. For this view there is not, so far as I am aware, any direct evidence, and these organisms must, I think, in the present state of our knowledge, be looked upon as a distinct group somewhat widely separated from the Saccharomycetes. Unlike the latter, they do not, as a rule, produce any alcohol, but on the contrary, thrive on the surface of alcoholic lquids, oxidising the alcohol away to carbon dioxide and water, or occasionally using a portion of it as food material. One or two species, it is true, seem to be feebly active in the direction of producing alcohol, but this is quite unusual. Some mycologists claim to have isolated a large number of distinct species, but having regard to the very variable nature of the mycoderma, both morphologically and physiologically, there can, I think, be very little doubt that some at least of these so-called species are merely varieties.

The mycoderma are very widely distributed in the air, and as their action is almost invariably pathogenic from the industrial point of view, they are of considerable significance to a large body of manufacturers. Thus, in the case of bottled beer, in which the bottles have not been properly filled, and in which a little air remains in the neck, this organism may be found as a film on the surface of the beer, which is in consequence rendered unsaleable.

In the case of wine, its effects are at times equally disastrous, the organism destroying the bouquet and frequently producing unpleasant substances, among which butyric acid has been observed. It should be pointed out that in the case of wine, at least, the ill effects of this organism have been noticed even in cases where there has been no obvious film, the results having been produced by cells in suspension. In such cases, however, the action is very much slower than when the cells are developing freely on the surface.

From *mycoderma* we may pass to the brief consideration of a further group of organisms frequently included in the *Fungi Imperfecti*. This inclusion is due not to any particular resemblance or connection between the members of this group, but to the fact that there is still a great deal of uncertainty attaching to their true genetic relationship to other organisms to which more or less well-defined positions have been assigned in the classification of the lower fungi. I propose to refer here only to *monilia*, *chalara*, *endomyces* and *ooidium*, four organisms which bear some resemblance to the Saccharomycetes on the one hand, and to certain of the moulds on the other, and which are therefore occasionally referred to as mould-yeasts. Thus, these organisms produce, on the one hand, cells not differing greatly in appearance from the Saccharomycetes, and like them often capable of producing alcohol, whilst, on the other, they resemble the moulds in giving rise to the production of well-marked mycelium.

In the case of *monilia*, both elongated, mycelium-like cells are formed as well as small more or less rounded cells, resembling yeast, which are capable of bringing about a vigorous alcoholic fermentation in liquids containing sugar. This organism occurs rather widely in fermented beverages, and is sometimes met with in bread, cereal foods and on the surface of ripe fruits. One species at least is possessed of marked pathogenic properties.

Chalara, like *monilia*, readily forms a film on the surface of nutrient liquids, and consists of branched mycelium and more or less rounded cells having a characteristic appearance under the microscope. This organism is met with in wine, milk, fruit juices, and many other foods—solid and liquid.

In the *ooidia* we have a class of organisms inclining more decidedly to the moulds, and often classified with the *Basidiomycetes*, but connected by many transitional forms

with other members of the *Fungi Imperfecti*, and therefore conveniently included in that heterogeneous grouping. The chief representative is the ordinary *ooidium lactis*, an organism which occurs very widely distributed in nature, and which is so frequently seen on the surface of sour milk, cheese, butter, pressed yeast, and many other products. Resembling *monilia* in some respects, it differs physiologically from that organism in possessing much feebler fermentative activity. It destroys the lactic acid in sour milk and in cheese, just as the *mycoderma* is responsible for its destructon in pickles and in other acid liquids. Thus, milk in which *ooidium* is growing may finally become neutral, or even slightly alkaline, owing to the decomposition of the protein constituents. In the case of certain cheeses, notably Camembert, this mould plays a not unimportant part in the so-called ripening process. One species at least, *ooidium albicans*, is pathogenic.

The genus *endomyces* resembles *ooidium* in some respects, especially in its morphological characters. The cells which form in the mycelium when free develop by budding or by division, but in many species asci are formed, containing from two to four spores. Several of these species have their habitat in the gummy or milky discharges from trees ,such as the oak, the maple, and the birch.

It was the well-known interest taken by Professor Lindner, of the Institut für Gärungs-Gewerbe, Berlin, in the investigation of the flora of these exuded tree-saps which gave, a few years ago, a new direction to the study of certain of the lower fungi. It had been for years a matter of common knowledge that ordinary yeast (*Saccharomyces cerevisiæ*) could be utilised for food purposes, either (chiefly for animals when merely dried, or, after having been submitted to a certain treatment, in the form of an extract closely resembling extract of meat in its appearance, flavour, and chemical composition. Apart from this, however, no attempt had been made to produce any of the microscopic fungi expressly for human food, and technical mycologists had restricted their attention to a study of the changes which these organisms were capable of bringing about in certain media, and of the products (alcohol, lactic acid, butyric acid, flavouring substances, etc.) of their activity. In 1916 Lindner received from one of his pupils, who was serving in the War on the Eastern Front, a small specimen of the exuded sap from the stump of a birch tree. On examining this microscopically it was found to contain only cells which resembled yeast-cells in appearance, and on submitting these to further investigation, and after pure cultures had been prepared, it was found that the predominant organism had the property of forming large proportions of fat, and of thriving in solutions containing the whole of the nitrogen in the form of ammonium salts. The organism grew freely on the surfact of carbohydrate solutions, forming a thick greasy film which, when separated and dried, contained 18 per cent. of fat, 31 per cent of crude protein, and 48 per cent. of carbohydrates. Given a cheap and abundant source of carbohydrate, and the necessary supply of nitrogen in the form of ammonium salts obtained from the air, it was evident that a food product rich in fat and protein could be produced in large quantity. We have it on the authority of Prof. Hayduck that at the outbreak of the War the German yeast-drying factories were fully mobilised, and produced some 20,000 tons of dried yeast annually, which was used for feeding purposes.

FARADAY SOCIETY.

June 14, 1926.

Gaseous Explosions at High Initial Pressures. By William A. Bone, D.Sc., F.R.S.

A *resumé* will be given of the researches which have been carried out during recent years in the Department of Chemical Technology of the Imperial College of Science and Technology upon the explosion of Hydrogen-Air and CO-air, etc., mixtures at initial pressures up to 175 atmospheres. Time permittin, the following points will be dealt with :— (1) the normal effects of increasing initial pressures upon the values of t_m and p_m/p_i in gaseous explosions; (2) " dissociation " and " radiation " effects at high explosion pressures; (3) N_2-activation and NO-formation in CO-Air explosions at high initial pressures; (4) spectrographic evidence of the absorption by N_2 of " radiation " emitted in such explosions; (5) the influences of argon and helium, respectively, as diluents upon $2H_2 + O_2$ and $2CO + O_2$ explosions at high initial pressures; and (6) new experimental evidence that the presence of moisture is not *essential* to CO-combustion.

NOTICES OF BOOKS.

Tin and the Tin Industry. By A. H. Mundey. Pp. XIV + 130. London: Sir Isaac Pitman and Sons, Ltd. 1926. Price 3s.

The earliest historical references to England are associated with the Cornish tin mines and the metal (our first export) continues to play an important part in the industrial life of the country. On account of the relative scarcity of its ores, tin is the most expensive of the extensively used metals and yet it has not been supplanted from the numerous commercial applications to which it has been put. These include the coating of other metals as in tin plate and the lining of vessels ;the preparation of alloys for engineering and other uses; and the application of tin compounds to the arts and sciences.

Among the alloys of tin, the bronzes take the prior position, some dating, we are told, from 900 B.C. They contained from 5 to 15 per cent. of tin. Sometimes early ones contained lead, and modern ones, zinc as well. The beauty of many bronze statues Mr. Mundey traces to the 'patina,' or gradual discolouration occasioned by exposure to the weather, and he gives the analyses of a number of continental bronze statues, all containing a trace of zinc. Bell metal, phosphor-bronze and phosphor-tin, are also described.

White metal alloys contain tin as an essential constituent. These are used for anti-friction bearings, printers' type, pewters and solders. Sometimes pure tin foil is used for wrapping, *e.g.*, chocolate; sometimes alloys are used, *e.g.*, for tobacco. The nature and scientific aspects of these alloys are discussed in a clear style and interesting manner, the section describing the pewters being particularly instructive.

The Cornish tin mines were long the chief European source of the metal, but have shown signs of exhaustion, the remaining ore being mixed with much wolfram, which involves further treatment in the extracting processes. Unlike the abandoned silver mines of Jachymov (St. Joachimsthal), Bohemia, the discovery of radioactive minerals has not, so far, brought about a general revival, although there have been recent signs of renewed activity in the Cornish mining industry.

Mr. Mundey is to be congratulated on this volume in Pitman's Common Commodities and Industries series. It sets out concisely the many ndustrial applications of the metal and its alloys. Mention is not made, however, of the extensive uses of tin salts and compounds, *e.g.*, in dyeing; neither is there any reference to 'tin pest.' The illustrations have been well chosen and the book should interest the general reader as well as the specialist.

J. G. F. D.

Thermo Dynamics for Students of Chemistry. By C. N. Hinshelwood, M.A. Pp. 186, with 11 diagrams. London: Methuen and Co.

The author of this work is a Fellow and Tutor of Trinity College, Cambridge, and it is explained that the book is largely based upon the lectures of the author at various times, in which his aim was to clear away difficult ties and make the "Fundamental ideas of thermo-dynamics as clear as possible." The result has been the production of an eminently practical and hence, useful, work, which ought to become popular with many students of chemistry.

Vinegar: Its Manufacture and Examination. By C. Ainsworth Mitchell, M.A. (Oxon.), F.I.C., Editor of the *Analyst.* Second and revised edition. XVI + 212 pp., with 5 plates and 49 illustrations. Price 10s. 6d. London: Charles Griffin and Co., 42, Drury Lane, London.

The author of this book is eminently qualified for the task undertaken, namely, the production of a book elucidating the "mysteries" connected with the manufacture of vinegar. As the author explains in his preface, there has been, hitherto, no book dealing adequately with the subject from the English point of view. The position was due to the secrecy observed by the various firms in keeping all possible information from not only the public, but also from their employees. The author's work has been facilitated by the assistance rendered by one of the leading and oldest firms connected with the business, and he has given us a book which will fill a blank in most libraries.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

12,259.—British Dyestuffs Corporation, Ltd.—Manufacture of dinitrotoluene. May 12th.
12,455.—Eldridge, G. S.—Production of soluble, etc., phosphates. May 14th.
12,259.—Everatt, R. W.—Manufacture of dinitrotoluene. May 12th.
12,372.—Niccoli, E.—Process for producing pure potassium salt. May 13th.

Specifications Published.

226,518.—General Chemical Co.—Manufacture of sulphuric acid by the contact process.
251,405.—Kalle & Co., Akt.Ges.—Process for separating enzymes from their solutions.
231,529.—Farbwerke Vorm. Meister, Lucius & Brunning.—Manufacture of sulphur dyestuffs.
251,526.—Akt-Ges Chemischer Werte.—Manufacture of quinine salts.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25 ,Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

249,647.—Clarifying solutions of salts.—Spencer, Chapman & Messel, Ltd., 36, Mark Lane, London; and Liebert, J. B., 4, Overbury Avenue, Beckenham, Kent.

Titanium, thorium, and zirconium salts.—Solutions of compounds of titanium, thorium, and zirconium, such as the solutions obtained by treating ilmenite or monazite with sulphuric acid, are clarified by adding gelatine or glue of animal origin and a light solid substance such as sawdust or asbestos. The mixture is allowed to settle for a time and is then filtered.

The Latest TRADE MARKS

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468,739.—Chemical substances used in manufactures, photography or philosophical research and anti-corcorrosives.—Sisson Bros. & Co., Ltd., Bankside, Sculcoates, Hull. May 26th.

KENMATTO.

468,887.—Chemical substances used in manufactures, photography, or philisophical research and anti-corrosives. — J. H. Fuller & Co., Ltd., 58, Minster Street, Reading, Berkshire. May 26th.

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THE CHEMICAL NEWS,

VOL. CXXXII. No. 3454.

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NOTES ON NEW ELEMENTS: I—V., AND CORRECTIONS.

By F. H. LORING.

I.

In the *Chemical News* of July 24, 1925, the writer worked out a scheme for evaluating the valencies of all the elements except those of the " rare-earth 13." This scheme is not put forward as a finished scientific method, obviously, but merely as a working plan for showing the range of valencies per element. Certain exceptions to the rule appeared. For example, zinc had to be assigned a rare value of 1. In this connection it may be of interest to note that copper has a high valency of 3 in rare instances. M. Vrtis (*Recueil des Travaux Chimiques des Pays-Bas*, 1925, XLIV., p. 425—the Brauner jubilee number), following on the work of Kruger, Crum, Krüss, Vitali, Kuzma, Brauner and others, confirms the existence of *trivalent* copper. Refering to the scheme (p. 51), assigning to copper valencies 1, (3) with an intermediate value of 2, and zinc (0), 2 gets over the difficulty of having to give this element a valency of 1. This change improves the scheme without adversely affecting the other values on each side of these elements as no change is needed in these cases. Incidentally, the rare zero value for Ni is made mathematically correct, since 8-3=0. Nickel is therefore (0), 2, 3. The round brackets indicate rare valencies, *e.g.*, He = 0, (2), as before.

There is still the difficulty of accounting for the extreme values (8) for ruthenium and osmium. It appears, however, that there are two factors to be taken into account in studying these problems. It seems safe to say the scheme represents fairly well the more characteristic valencies, or at least the normal or fundamental range of valencies. Now ruthenium and osmium are comparatively large-mass elements, and at the same time they have the strong characteristic of forming a long range of oxides. In short, they have as it were, a large appetite for oxygen. Now their atoms being large in mass, may tend on this account to hold more oxygen, so that *when these two factors are common to one element*, compounds are formed apparently representing higher valency values than otherwise would be the case. RuO_4 and OsO_4 are therefore to be expected, while the remaining elements of Group VIII would have the lower valencies as shown. It will be seen that all of the 8 valencies need not, as it were, emanate from these metals, that is to say their atoms, for it makes no difference how the valencies are made up or just how they emanate because the problem at this stage only deals with the question from the point of view of extra ' mass absorption ' beyond that represented by the more normal valency range as indicated by the scheme.

Manganese, it will be noted, is another element the atoms of which take up various numbers of oxygen atoms, even up to the extreme Mn_2O_7. It would, therefore, be expected that elements 43 and 75 have a considerable range of affinity for oxygen, and form a series of oxides, but their atoms being more massive they, too, may tend to overstep the normal limit and form higher oxides.

II.

It is of historical interest to record here the following taken from de Broglie's " X-Rays," English translation, 1925, p. 127— " The existence of celtium, the third constituent of ytterbium found by G. Urbain, could not be established, at first, on account of the very low celtium content of existing preparations. Dauvillier (*Comptes Rendus*, 1922, 1, 1319), by carefully examining the spectrum of one of these preparations, had found two very feeble lines α_1 = 1.5618 A. and β_2 = 1.3194 A., close to numerous ytterbium and lutecium lines. These would appear to belong to the *L* series of the element 72 and should thus confirm the existence of celtium." Coster and Hevesy early in 1923 announced that they had found element 72 in zirconium minerals by means of X-rays and had identified this element with zirconium as regards chemical type in accordance with its periodic place as predicted by Bohr and others (*e.g.*, see A. W. Stewart's " Recent Advances in Physical and Inorganic Chemistry," 1919, p. 184, where Ct is placed provisionally in Group IV). See also *Chemical News*, 1912, CVI., p. 37,

where reasons are given by the present writer for expecting 13 elements of the rare-earth type to exist in the region from praseodymium to the end member of the series, inclusive. Now that element 61 has been recently discovered the series from Pr (59) to Lu (71) numbers 13. The filling of all the Moseley gaps is therefore in agreement with this number. Celtium consequently is excluded from the series as could have been predicted earlier had the number 13 been regarded as absolute.

III.

In addition to the above the following letter (over the signature of the present writer) which appeared in the Sunday *Observer*, April 4, 1926, is here given by way of a *historical summary* :—

"Sir, the account given under the title of 'The Missing Elements' in the *Observer* of March 21 last is both instructive and accurate; but I should like to point out matters in dispute which may eventually alter the results.

In the first place, the discovery of the element of atomic number 72, as stated, was by Coster and Hevesy, but Professor Urbain has claimed priority, as it turned out to be (at least in Professor Urbain's opinion) the element *celtium* of Urbain and Dauvillier; and although the evidence seems to be favourable in many ways to the two first-named scientists, we feel that we must await the decision of the International Committee on the Chemical Elements, *whose opinion will no doubt be* recognised in this country as final.

In the second place, the elements of atomic numbers 43 and 75 are claimed as discovered by three German scientists, who are working in collaboration, Professor Noddack, Dr. Ida Tacke, and Otto Berg. The last-named collaborator had conducted the X-ray experiments which are most important in discoveries of this kind, as you have already indicated.

And, finally, Dr. J. G. F. Druce and the present writer succeeded in finding element 75 in manganese sulphate by X-ray analysis carried out by the writer in collaboration with Messrs. Adam Hilger, Ltd., the X-ray work being done in their research laboratory in London. These results were published in the *Chemical News*, October 30 and November 27, 1925. This finding was almost simultaneously confirmed jointly by Dr. Dolejsek and Professor Heyrovsky, of Prague, an account of which appeared in *Nature* on November 28, 1925.

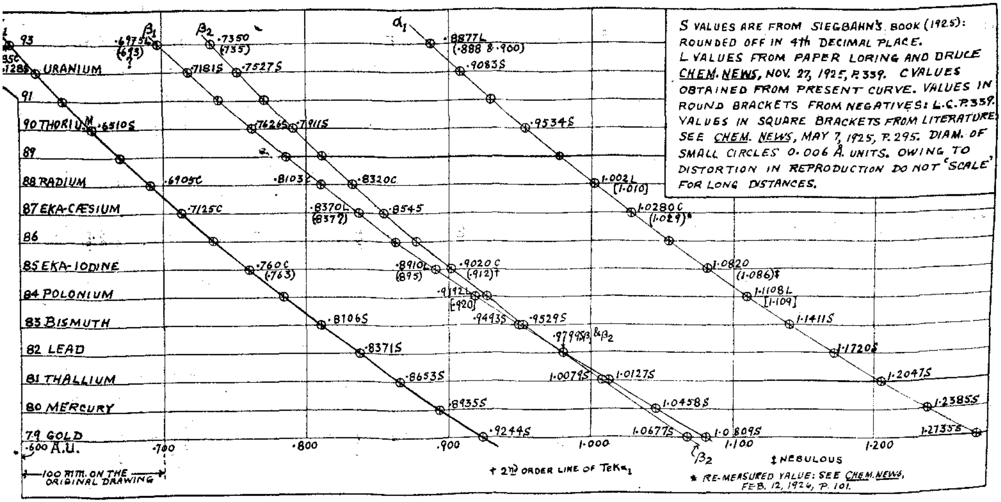
The X-ray analysis was so important in our research that Dr. Druce took a sample of the material containing element 75 to the Charles' University at Prague in order to get further confirmation. At this University Dr. Dolejsek (who has collaborated with Prof. Siegbahn ,one of the greatest authorities in the world on X-ray work) made an analysis, spectrocopically, by means of X-rays, and the result was that *the three strongest lines of the new element* 75 were obtained from the sample above mentioned. The spectrum was shown on the screen at the lecture room of the Chemical Society, London, on January 21, 1926, when a short account of the work was given.

It will be seen that the discovery of element 75 appears to rest with the German scientists, but Dr. Dolejesek and Prof. Heyrovsky have questioned the evidence given by the X-ray spectrum the German scientists have published, at the same time *acknowledging priority* on our *side* with respect to their own work. The matter is therefore *sub judice*, and further investigation will be necessary before the International Committee on the Chemical Elements can decide the issue."

IV.

The accompanying curve-diagram shows the four stronger lines in the *L* series for elements *from gold to the extreme hypo*thetical member of atomic number 93, and is inherently explanatory. No importance should be attached to exact coincidence of the experimental with the proper values.

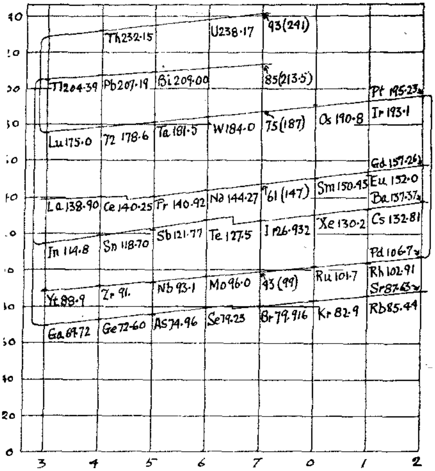
It must be remembered that all the lines entered in round brackets are not sharp, clear lines, several being nebulous. It will be seen that practically all the 'stranger' lines on the negatives so far obtained are seemingly accounted for, barring a nebulous line 0.950. Lines 0.768 and 0.651 cannot be considered proper lines, and they should be ruled out, the reason for this observation having already been given. As stated before, line 1.029 falls in a region comparatively free from possible known lines, as will be seen on consulting Günther's table (*loc. cit.*). The original lines 0.888 and 0.897 have been re-measured and re-calculated, with the result that the latter becomes 0.900. The other value stands. They were both good lines on one negative.



In the *Chemical News*, Feb, 12, 1926, the writer cited the following line intensities :—$L\alpha_1$ 125, $L\beta_1$ 100, $L\beta_2$ 49, $L\gamma_1$ 38, $L\beta_3$ 15 On the same scale, $L\beta_1$ = 100, P. Günther in his " Tabellen zur Röntgenspektralanalyse," 1924, gives the following values :—$L\alpha_1$ 125, $L\beta_1$ 100, $L\beta_2$ 75 $L\gamma_1$ 87.5, $L\beta_3$ 87.5. For the *K* lines, on the scale $K\alpha_1$ = 125. Günther's values are :—$K\alpha_1$ 125, $K\alpha_2$ 100, $K\beta_1$ 50, $K\beta_2$ 12.5. The $L\alpha_2$ line appears to have a strength of about 1/10th that of the $L\alpha_1$ line according to Siegbahn, but Günther gives the ratio 10 : 3. Line intensities have been measured by ionisation methods and they may not agree altogether with the photographic intensities. The coincidence of weak alpha lines of impurities may alter the intensities of some of the lines being judged. Variations in the sensitivity of the photographic emulsion are to be expected. Opinions in these matters differ and results will vary. Günther gives the Hg$L\beta_2$ line as 1.0375, while de Broglie (*loc. cit.*) gives it as 1.042. There is a weak line between the 0.895 and 0.912 lines. Siegbahn in his book refers to a 'stranger' line of wave-length 1.086 in connection with doubtful tungsten lines. In the inset above, " May 7, 1925," should read, May 7, 1926.

V.

From the accompanying curves and table is will be seen that the atomic weights of the above elements can be approximately estimated assuming that the higher members exist.



VALENCY.	ELEMENTS.	ISOTOPES.		AT. NOS.
1	POTASSIUM	39	41	19
2	CALCIUM	40	40	20
GROUP VII	BROMINE (35)	79	81	39-4= 3
1	POTASSIUM	39	41	19
2	NICKEL	60*	60*	28
GROUP VII	EKA-Mn (43)	99	101	47-4
1	RUBIDIUM	85	87	37
2	CALCIUM	40	40	20
GROUP VII	IODINE (53)	125	127	57-4 = 5
1	RUBIDIUM	85	87	37
2 &c.	MOLYBDENUM	96	96	42
GROUP VII	DVI-Mn (75)	181	185	79-4
1	RUBIDIUM	85	87	37
2 &c.	TELLURIUM	128	130	52
GROUP VII	EKA-I (85)	213	217	89-4=
1	POTASSIUM	39	41	19
2	MERCURY	202	202	80
GROUP VII	93	241	243	99-6
1	RUBIDIUM	85	87	37
2	NICKEL	60*	60*	28
RARE EARTH 61†		145	147	65-4

* OR Ni 58, 58.
† 7th ELEMENT IN SERIES FROM Xe-0.

It is not yet proved that any of these elements, including those which are obviously hypothetical, can be formed in the X-ray tube as suggested as a possibility in the *Chemical News*, May 14, 1926, p. 311. A selection of isotopes would have to be made as iodine has only one value, 127. The isotopes of molybdenum are not yet known, but 96 seems a probable value.

CORRECTIONS.

In the previous article (May 14) page 311 the following should be noted.— P. 311, top of table, delete full stop after "Mass." Insert as alternatives to Ni 60, 60; Ni 58, 58. In REFERENCES, p. 312, first line, "662" should read 622. In last paragraph, fourth line from end, delete "happening." In the article in the issue May 7, 1926, p. 295, the last line should read: Radium is 0.008 high, while the other two values agree with the calculations as near as could be expected. On p. 296, first line of last paragraph, insert a comma after "drawing." The suggestion that the potassium phosphate might have been derived (in part) from residues or bittern (see page 312) now seems probable in so far as it appears on investigation that the compound contains bromine.

BRITISH ASSOCIATION—SECTION B.

DISCUSSION ON THE ALTERNATING EFFECTS IN CARBON CHAINS.

September 1st, 1925.

(Summary of the Positions taken up by the Different Participants in the Discussion.)

DR. B. FLURSCHEIM.

An alternating effect in carbon chains is now generally admitted. Does it consist of alternating amounts of free and bound affinity force (' affinity theory '), or of varying distributions of electrons (' polarity theory ')?

The *polarity theory* defines the attractive force between non-ionised atoms as an electrostatic attraction between shared electrons and the atomic nuclei. But instead of forming a bridge between the physical structure of the atom and its chemical behaviour, this conception creates difficulties both physical and chemical. Physically, it conflicts with the Rutherford-Bohr-Sommerfeld theory, as evinced by the failure of attempts to devise even a stable hydrogen molecule model with shared electrons; by the impossibility of obtaining identical frequencies in a sub-group of carbon electrons if these were shared with ' electronegative ' atoms differing materially from each other in their outer electronic frequencies; by the racemisation of asymmetric carbon without rupture of bonds; by the difficulty of reconciling shared electrons with the precession and rotation of orbits, etc.

Chemically the polarity theory is based on an assumed stability of octets. But N_2 and NO, with either incomplete or " strained " octets, are less reactive than, respectively, NH_3 and N_2O with complete octets. Moreover, there is no analogy between the assumed octet stability of a charged atom and the proved octet stability of neutral neon or argon. Of the various forms in which the polarity theory has been published, those which are unequivocal are contrary to experimental evidence; the remainder consist of arbitrary alternatives which in so far as they can be tested at all, are similarly refuted.

The unequivocal forms of the polarity theory (Fry, Vorländer, Pauly, Lowry, Crocker) may be indicated by the scheme

$$\overset{+}{A}—\overset{-}{B}—\overset{+}{C}—\overset{-}{D}—\overset{+}{E}—\overset{-}{F}.$$

This scheme frequently leads to a wrong prediction of the positions of substituents entering the benzene nucleus; for example, in the nitration of phenyl-propiolic acid, tertiary butyl benzene, etc. It is conflict with various cases of ring formation, reduction, replacement, scission and condensation.

It is not in harmony with the facts in the transformation of p-hydroxyphenyl-iodo-chloride into chloro-iodo-phenol, where a negative chlorine atom has been shown by McCombie to enter the nucleus at a position ortho to the -OH group.

In a variety of cases the scheme points to affinity constants for acids which are not in agreement with the observed values.

Lapworth and Robinson have each advanced forms of the polarity theory which offer several alternative formulæ for the same compound. In Prof. Lapworth's theory the alternative arrangements are :—

$$(1)\quad \overset{+}{A}—B—\overset{-}{C}—D—\overset{-}{E}$$

$$(2)\quad \overset{-}{A}—\overset{+}{B}—C—\overset{+}{D}—E$$

$$(3)\quad A—\overset{-}{B}—\overset{+}{C}—D—\overset{+}{E}$$

These views, however, again lead in a number of cases to wrong prediction of the position taken up by substituents entering the benzene nucleus; for example in the *p*-chlorination of anisol by SO_2Cl_2, PCl_5, etc. The rearrangement of p-hydroxyphenyl-iodo-chloride already referred to, the oxidation of triphenylamine to tetraphenyl-benzidine, the reduction of benzotrichloride to stilbene-tetrachloride, the condensation of benzaldehyde with chloroform, and the ready transition of o-phenylbenzoylchloride into fluorenone, are examples of reactions not reconcilable with Prof. Lapworth's hypothesis, in spite of the latitude afforded by his three alternatives. In a number of cases also the

affinity constants of acids are found to conflict with deductions from Prof. Lapworth's theory.

Prof. Robinson's alternatives are the *following* :—

$$(1)\quad \overset{-}{A}-\overset{+}{B}-C-\overset{+}{D}-E$$

$$(2)\quad \overset{+}{A}-B-\overset{-}{C}-D-\overset{-}{E}$$

$$(3)\quad A-\overset{-}{B}-C-D-\overset{+}{E}$$

Scheme (2), however, involves the spontaneous separation of charges, an atom with greater electron affinity losing an electron to an atom with lesser electron affinity.

Schemes (1) and (3) should direct $\overline{\text{Cl}}$ and $\overline{\text{OH}}$ to the *ortho* position, (1) should direct these substituents also to the *para* position; so that the nitration of benzoic acid for instance, should produce salicylic acid and nitrous acid.

If (2) produces o-p substitution in phenylpropiolic acid ,etc., then it should also do so in benzonitrile, etc. If (2) accounted for *m*-nitration of benzylamine, there would only be one electron between the nucleus and the α-carbon atom, so that nitric acid would split off the side chain.

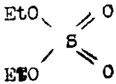
Robinson's theory is in conflict with other cases of aromatic substitution, of reduction, condensation and rearrangement. Altogether 29 definite examples were cited against the unequivocal form of the polarity theory.

The *Affinity Theory* accepts the attractive force between non-ionised atoms—like gravitational and magnetic forces—as some given function of the atom, and deduces for this force one single mechanism of transmission, in any chain. Its interpretation of chemical reactions is uniquivocal, and is *found to be in agreement with al well-authenticated observations.*

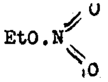
Prof. T. M. Lowry.

It is now nearly three years since the speaker introduced the conception of "mixed" or "semi-polar" double bonds, i.e., of double bonds made up of one co-valency and one electro-valency, as shown in the symbol $>\overset{+}{C}-\overset{-}{C}<$, instead of a double co-valency or a double electrovalency as shown in the formula $O=O$ and $\overset{++}{Ca}\,\overset{--}{S}$. This novel conception was received at first with a great deal of incredulity, but has recently been verified in such a conclusive manner that it is no longer possible to deny the real existence of this type of union.

The first method of verification depends on Sugden's correlation of chemical composition with the physical properties of density and surface tension. Sugden's *parachor realises, after the lapse of half a* century, the ideal which Kopp and others set before them of a function which can be calculated with certainty for a compound of given composition, without being affected to any marked extent by the physical conditions under which the measurements are made. Determinations of the parachors of ethyl sulphate and ethyl nitrate show that the former contains no ordinary double bond and the latter only one, corresponding with the formulæ



and



Since the nitro group contains one non-polar and one semi-polar double bond, it is clear that the prediction of the orienting effect of the group, either from the atoms it contains, or from the nature of the bonds between them is a less simple operation than has generally been supposed.

The speaker's views have received further confirmation by Dr. Phillips' discovery of optically active sulphinates of the type :

$$CH_3.C_6H_4.SO.OEt.$$

In the conventional formula the $S=O$ group is always represented as containing an ordinary double bond; this formula, therefore, gives rise to a symmetrical model, and it is only when the *non-polar* is replaced by a *semi-polar* double bond, as in the symbol $>\overset{+}{S}-\overset{-}{O}$, that the possibility of optical activity is indicated. The resolution into optically-active forms of a series of compounds of the type in which the presence of a *semi-polar double bond* is indicated by Sugden's measurements of surface tension and density is therefore a decisive vindica-

tion of the new conception which is embodied in the "polar" formulæ for these compounds.

Whilst the existence of "semi-polar" bonds has thus been established in a large number of compounds containing the groups $\geqslant$NO $\geqslant$PO and $>$SO, it is noteworthy that there is no case in which the group $>C=C<$ has been found to give values corresponding with a semipolar form of the double bond. These groups, therefore, appear to exist normally in a non-polar form. There are, however, good reasons for supposing that the rupture of one link of the bond which occurs in chemical changes such as the formation of addition compounds, is an unspmmetrical process, which can be formulated as depending on the transient formation of a semi-polar bond in an activated phase of the molecule. In the case of conjugated compounds these ideas lead to an alternation of double and single bonds in the resting form of the molecule, but of positively and negatively charged atoms in its activated form. Since the controversy in reference to the law of alternation in carbon chains is concerned primarily with the question whether the alternation is in the character of the successive *atoms* or of the *bonds* between them, it is quite possible that both views are correct, but that the two alternative theories refer to two different conditions or forms of the molecule.

Holleman has suggested that formulæ of the type

or

appear to predict a marked similarity between the characteristics of the *o* and *m* positions and a wide difference from those of the *p* position. This interpretation of his views has been repudiated by Flürscheim; it is, however, in harmony with observations on the absorption spectra of the nitro phenols, the *o*- and *m*- compounds showing in this respect a curious similarity, and differing in a notable way from the isomeric *p*- compound.

If Flürscheim's "strong" and "weak" affinities are to be interpreted literally then a maximum orienting effect must be developed in the fluoro derivatives of benzene, since no stronger link is known in organic chemistry than that which binds carbon and fluorine together. In p-fluorochlorobenzene, however, it is the chlorine and not the fluorine which takes control.

Finally, in the speaker's opinion, it is the *mechanism of substitution* that requires investigation; *the empirical laws of substitution* are means to an end, and as such are only of secondary importance. Professor Robinson's views on the diazo-coupling of phenols and amines are a constructive suggestion of the highest value in this connection.

(To be continued.)

THE CHEMICAL INDUSTRY IN CANADA IN 1925.

Canada's chemical industry showed substantial progress in 1925. Production by the 511 plants reporting in 1925 was valued at $114,831,880, an increase of six million dollars over the reported value of sales in the preceding year. Capital employed remained practically unchanged at 126 million dollars. Materials cost nearly 3 million dollars more at a total of $57,000,429. Employment showed little change; 13,973 workers earned $17,596,561 during the year.

In Canada's foreign trade there were substantial gains both in the imports and the exports of chemicals. Total imports for the year of chemicals and allied products had a value of +27,653,819 as compared with a total of $24,565, 574 in 1924. In the export field there were important gains in the fertiliser and heavy chemical groups, and appreciable gains were made in the exports of soap. An analysis of the trend of Canada's external trade in chemical products shows that the value of imports in this class from the United States made up 66 per cent. of the total brought in from all sources; 16 per cent. of the value of purchases represented goods from the United Kingdom; the balance, or 18 per cent., was derived from other countries, chief among which were, Germany, France, Netherlands, Chile Belgium, Switzerland and the Argentine. There was an increase in the relative value of chemical products exported from Canada to the United States in 1925 and a decrease in the percentage shipped to the United Kingdom.

Prices of chemical products declined slightly during the year. Based on 1913 prices as 100, the Bureau of Statistics' index number on chemicals and allied products,

which showed an average of 161.8 in 1924, declined to an average for the year of 157.1 with only slight variations from month to month.

COAL TAR AND ITS PRODUCTS.

Production valued at $3,100,998 included creosote oils and other special oils, pitch, refined tar, cresylic acid, tarred felts, roofing cement, disinfectants and insecticides as principal products.

ACIDS, ALKALIES, SALTS AND COMPRESSED GASES.

The production of industrial chemicals such as sulphuric, hydrochloric, and nitric acids, caustic soda, salt cake, calcium carbide, cyanamide, phosphorus, and industrial gases such as oxygen, hydrogen and acetylene, forms the foundation of the chemical industry in Canada. Forty plants in this industry representing a capital investment of $35,640,753, furnished employment to upwards of 2,400 workers during the year and converted $12,887,308 worth of ray materials into finished products valued at $28,546,765, an advance of 2.3 million dollars over the total value of the output in 1924. Large scale operations and localisation of production within easy reach of the consuming market are characteristics of the heavy chemical industry in any country.

EXPLOSIVES, AMMUNITION, FIREWORKS AND MATCHES.

There was a slight shrinkage in the value of the products made in the explosives industry in 1925 in comparison with the records of the preceding year. Imports of explosives into Canada during the year were valued at $354,482, and exports in the same period reached a value of $154,078. Investigatory work in recent years has shown the feasibility of using lower priced explosives in many fields, and it is probable that, although the value of the output in 1925 was less than the total reported for the preceding year, the actual volume of production in the explosives industry in Canada was greater than in 1924.

FERTILISERS.

In a review limited to the consideration of the industry as represented by those plants which produce mixed fertilisers as their main product, only a partial survey of the industry as a whole is available. In 1925, thirteen plants in this class representing a capital investment of $2,068,936 employed about 200 men and produced commodities valued at $1,307,430. This total showed a slight gain over the corresponding total of $1,277,145 reported in 1924.

MEDICINAL AND PHARMACEUTICAL PREPARATIONS.

Plants for the manufacture of medicinal and pharmaceutical preparations were in operation in six provinces in 1925, but the industry is fairly well centred in Ontario, Quebec and Manitoba. There were 120 plants in operation in 1925 as compared with a total of 104 in the preceding year. Production for the year was valued at $13,843,154, as against $13,350,347 in the preceding year. In each year raw materials cost slightly less than 5 million dollars. Imports of medicinal and pharmaceutical preparations and other drugs were valued at $2,968,089.

PAINTS, PIGMENTS AND VARNISHES.

Production in the paints, pigments and varnishes industry in 1925 reached a value of $21,900,808, or 1.7 million dollars above the valuation placed on the output in 1924. Materials cost 12.3 million dollars in 1925, as against 11.6 million dollars in the preceding year.

SOAPS, WASHING COMPOUNDS AND TOILET PREPARATIONS.

In 1925, Canada's 88 plants in the soaps, washing compounds and toilet preparations industry produced commodities valued at $17,633,905 from materials worth slightly in excess of 10 million dollars and furnished employment to upwards of 2,000 persons.

INKS, DYES AND COLOURS.

The inks, dyes and colours industry includes all concerns producing printing and writing inks, as well as a variety of other products such as dye soaps, mortar colours, shingle stains, hat colours, caramel, mucilage and paste. In 1925, there were 27 plants, and their production was valued at $2,765,618.

WOOD DISTILLATES AND EXTRACTS.

Output values once again receded in the wood distillation industry in 1925 to a total value of $1,981,368 as against $2,283,422 in 1924 and $2,743,295 in the preceding year.

MISCELLANEOUS CHEMICAL INDUSTRIES.

In addition to all the other industries reviewed in the preceding paragraphs there

were 119 plants producing chemical products of various kinds in Canada during 1925. The output of these factories reached a value of $10,784,202 from materials which cost $4,955,571. Nearly 1,700 persons were employed.

OVER $600,000,000 CAPITAL FOR CANADIAN MINES.

The Natural Resources Intelligence Service at Ottawa reports that statistics compiled by the Dominion Bureau of Statistics at Ottawa show that investments in Canadian mines to date amount approximately to $632,444,000. Of this sum, $481,328,000 is invested in metal mining and metallurgical works treating Canadian ores. Investment in non-metal mines totals $259,361,000 and the cost of properties and plants producing structural materials and clay products is $91,255,000.

Investment in coal mining accounts for 23 per cent. of the total capital employed in the mining industry. Gold quartz mines represent another 13 per cent. of the capital, metallurgical work 10 per cent., natural gas 8 per cent., nickel, copper and silver-cobalt 7 per cent. each, cement 6 per cent., clay products 5 per cent.

CANADA'S EXPORTS UP ONE-QUARTER.

An increase of nearly $250,000,000 in the exports of the Dominion is shown by the March trade report just completed. The report is for the fiscal year ending March 31, and the total was $,315,192,791. Imports were $927,402,732, which was an increase of $130,470,195.

Imports from the United States far exceeded those from the United Kingdom during the past year. The total was up by more than $100,000,000 to a total of $609,825,350, and exports to the United States increased by more than $57,000,000 to $474,890,028.

Exports to the United Kingdom again exceeded those to the United States, being $508,249,576, which was an increase of more than $112,000,000, and imports from Great Britain rose by $12,000,000 to $163,710,431.

THE QUANTUM THEORY OF THE DIELECTRIC CONSTANT OF HYDROGEN CHLORIDE AND SIMILAR CASES.

By LINUS PAULING.

The quantum theory of diatomic dipoles.—Using the treatment of Pauli, an expression for the dielectric constant of a diatomic dipole gas is obtained, in which half-quantum numbers are used. It is shown that for cases of practical interest the approximation suggested by Pauli is not valid; hence numerical values of the temperature-function C have been calculated and tabulated.

Application to experimental measurements.—The theory has been applied in the interpretation of Zahn's measurements of the dielectric constants of the hydrogen halides. The electric moments of molecules of hydrogen chloride, bromide, and iodide were found to be 0.3316, 0.252, and 0.146×10^{-18} cgsu respectively; *i.e.*, only about one-third of the values given on the basis of the classical theory. Moreover, the values 0.00077 and 0.00102 for $4\pi N_0 \alpha$ for hydrogen chloride and bromide, in which α is the coefficient of induced polarization, are shown to be in better agreement with measurements of indices of refraction than are the classical theory values. A discussion is given of possible inaccuracies in the theory, of the choice of quantum numbers, and of the possibility of weak quantization. — *Abstracted from "The Physical Review,"* U.S.A.)

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL SOCIETY CONVERSAZIONE.

The Annual Conversazione was held on June 16, there were fewer exhibits than usual but the number of guests was perhaps greater.

Among the notable exhibits of interest to chemists and physicists were Prof. W. L. Bragg's models of crystal structure and Prof. Lindemann and Dr. Dobson's photo-electric photometer, the National hysical Laboratory shower a Vector Colorimeter, Messrs. Adam Hilger, spectrograms and special polarimeter tubes. Mr. W. A. D. Rudge exhibited mechanical models to illustrate the structure of the atom, rapidly rotating lumps representing the electrons.

Other exhibits of general scientific

interest include Mr. G. H. Gabb's early microscope of the Leeuwenhoek type, *circa* 1680, and a portrait of Leeuwenhoek, a mezzo-tint by van Verkolje.

The Department of Geology of the Natural History Museum showed plaster casts of Archaeopteryx, and Mr. R. D. Oldham exhibited the Stomachion or Loculus of Archimedes.

In embryology there were exhibits by Mr. T. S. P. Strangeways and Dr. H. B. Fell, in which the eyes of embryo fowls after a period of 64-70 hours had been dissected out. These embryo eyes had grown normally when separated from the parent body, and specimens were exhibited showing the growth of the lens, the formation of pigment, the differentiation of the iris, and the development of the reticular, ganglion cells, and layers of the retina.

SOCIETY OF CHEMICAL INDUSTRY.

President—

W. J. Uglow Woolcock, Esq., C.B.E.

The Forty-Fifth Annual Meeting and Congress of Chemists is to be held in London, July 19 to 23, 1926. The following Societies are co-operating :— Chemical Society, Institute of Chemistry, Association of British Chemical Manufacturers, British Association of Chemists, British Chemical Plant Manufacturers' Association, Bio-Chemical Society, Coke Oven Managers' Association, Institute of Brewing, Institute of Metals, Institution of the Rubber Industry, Institution of Chemical Engineers, Institution of Petroleum Technologists, Oil and Colour Chemists' Association, Society of Leather Trades' Chemists, Society of Public Analysts, and the Chemical Industry Club.

Patron—His Majesty The King.

PROGRAMME OF ARRANGEMENTS.

Monday, July 19.

10 a.m.—Fourth Annual Corporate Meeting of the Institution of Chemical Engineers at the Central Hall, Committee Room D, Westminster. Business, and Presidential Address by Sir Frederic L. Nathan, K.B.E., *on* "Industrial Efficiency and the Elimination of Waste.' '

11.30 a.m.—Opening of the Exhibition of hemical Plant at the Central Hall, Westminster, by Sir Max Muspratt, Bart, President of the Federation of British Industries. The Exhibition arranged by the British Chemical Plant Manufacturers' Association.

2.30 p.m.—At the Mansion House, in the presence of H.R.H. the Duke of York, K.G., the Rt. Hon. the Lord Mayor, Sir William R. Pryke, presiding, the presentation of the Society's Messel Medal to the Rt. Hon. the Earl of Balfour, K.G., O.M., F.R.S. The Messel Memorial Lecture will thereafter be delivered by Lord Balfour. Admission by ticket only. (Limited to 500.)

6.30 for 7 p.m.—Annual Dinner of the Institution of Chemical Engineers in the Empire Room, Hotel Great Central. (*Ticket 8s. 6d., exclusive of wine.*) Applications to the Honorary Secretary of the Institution.

8.15 p.m.—Reception by the President of the Society of Chemical Industry (W. J. U. Woolcock, Esq., C.B.E.) in the Winter Garden, Hotel Great Central.

9 p.m.—Smoking Concert in the Wharncliffe Rooms, Hotel reat Central. Admission by ticket.

Tuesday, July 20.

9.30 a.m.—Meeting of the Council of the Society of Chemical Industry in the Red Room, Hotel Great Central.

10 a.m.—Annual Meeting of the Society of Chemical Industry (for Members only) in the Marylebone Room, Hotel Great Central. Business, and Presidential Address by W. J. U. Woolcock, C.B.E.

10.30 a.m.—Joint Meeting of the British Chemical Plant Manufacturers' Association, the Institute of Metals, the Institution of Chemical Engineers, and the Chemical Engineering Group for a Symposium on "Corrosion" in the Empire Room, Hotel Great Central. Papers will be read by :—

(1) Mr. Ulick R. Evans : "Fundamental Principles of Corrosion."

(2) Mr. W. H. Hatfield : "Chemically Resistant Steels for Chemical Engineering."

(3) Mr. P. Parrish : "Corrosion and Erosion."

(4) Mr. R. J. Sarjent.

11 a.m.—Joint Meeting of the Bio-Chemical Society with the London Section of the Society of Chemical Industry in the Regent Room, Hotel Great Central. Subject : "The Scientific and Industrial Problems presented by the Hormones—the Natural Drugs of the Body." Chairman : The Rt. Hon. Sir Alfred Mond, Bart., M.P. Papers will be read by :—

(1) Dr. H. H. Dale, C.B.E., Sec.R.S. : "The Experimental Study and Use of Hormones."

(2) Dr. H. W. Dudley : "The Chemistry of the Pituitary Gland and of Insulin."
(3) Mr. F. H. Carr, C.B.E. : "The Commercial Production of Hormones."
(4) Dr. H. A. D. Jowett : "The History of Adrenaline."
(5) Prof. G. Barger, F.R.S. : "Recent Progress in the Chemistry of Thyroxine."
(6) Dr. J. W. Trevan : "Biological Assay of Hormones."

A general discussion will follow the papers.

1.15 for 1.30 p.m.—Lunch in the Winter Garden, Hotel Great Central, by invitation of the London Section of the Society of Chemical Industry.

2.30 p.m.—Annual Meeting of the British Chemical Plant Manufacturers' Association, at 166, Piccadilly, W.1.

3 p.m.—Discussion on "Chemistry House," to be opened by Dr. Stephen Miall. This meeting, arranged by the British Association of Chemists, will be held in the Marylebone Room, Hotel Great Central, and is open to Members of any of the Societies.

4 to 6 p.m.—Garden Party at the Royal Botanic Gardens, Regent's Park, N.W.1., by invitation of the Rt. Hon. Sir Alfred Mond, Bart., M.P., and Lady Mond. The Central Band of H.M. Air Force (by permission of the Air Council).

6.30 for 7 p.m.—Annual Dinner of the British Chemical Plant Manufacturers' Association at the Hotel Great Central.

8.30 p.m.—Reception in the Winter Garden and Dance in the Wharncliffe Rooms, Hotel Great Central.

WEDNESDAY, JULY 21.

10.30 a.m.—Annual Meeting of the Society of Chemical Industry in the Marylebone Room, Hotel Great Central. Addresses by Sir Joshia Stamp, G.B.E., and Sir Max Muspratt, Bart. Chairman : The President of the Society of Chemical Industry, W. J. U. Woolcock, Esq., C.B.E.

Afternoon.—Visits to Works and Laboratories :—
(a) General Electric Co., Ltd. (Osram Robertson Lamp Works), Hammersmith (limited to 140).
(b) Watney Sombe Reid & Co., Mortlake.
(c) Bryant & May, Ltd., Bow, E. (limited to 200).
(d) Research Laboratory of the British Rubber and Tyre Manufacturers, Croydon (limited to 12).
(e) Research Station, The Anglo-Persian Oil Co., Sunbury (limited to 30).
(f) Whitbread's Brewery, Chiswell Street, E.C.1. (limited to 50).
(g) London Wholesale Dairies, Harrow Road (limited to 30).
(h) Naylor Bros., Ltd., Paint Works, Slough (limited to 30).

Whole Day.—A whole day charabanc drive through Surrey has been arranged for the ladies. The places visited will include Ockham (lunch at the Hautboy Hotel), Ripley, Newlands Corner, Leith Hill, Ockley (tea at the Red Lion Inn) and Dorking. Tickets, 12s.6d. inclusive.

7.30 p.m.—Reception by the President of the Society of Chemical Industry in the Winter Garden, Hotel Great Central.

8 p.m.—Annual Dinner of the Society of Chemical Industry in the Wharncliffe Rooms, Hotel Great Central. Tickets, 12s. 6d., exclusive of wine.

THURSDAY, JULY 22.

10.30 a.m.—Annual Meeting of the Society of Chemical Industry, in the Marylebone Room, Hotel Great Central.

Joint Meeting arranged by the Chemical Engineering Group with the Institution of Petroleum Technologists, and the Institution of Chemical Engineers on "Power Alcohol." Chairman : Sir Thomas Holland, K.C.S.I., K.C.I.E., F.R.S.

Papers will be read by :—
(1) Dr. W. R. Ormandy : "Sugar from Wood."
(2) Mr. Douglas Ross and Dr. W. R. Ormandy : "Experiences with Alcohol Motor Fuels."

10.30 a.m.—Joint Meeting of the Institution of the Rubber Industry and the Oil and Colour Chemists' Association, in the Regent Room, Hotel Great Central. Chairman : Sir William Bragg, K.B.E., F.R.S. Subject : "The Influence of Particle Size in the Paint and Rubber Industries." Discussion to be opened by Dr. D. F. Twiss (Rubber Industry) and by Dr. H. Houlston Morgan and Mr. . A. Klein (Paint Industry).

Afternoon.—Visits to Works and Laboratories :—
(a) National Physical Laboratory, Teddington.

(b) Burroughs, Wellcome & Co., Chemical Works, Dartford (limited to 50).

(c) *British Drug Houses, Ltd., City Road,* N.1. (limited to 80).

(d) Chemical Laboratories and Physics Laboratory of the Imperial College of Science and Technology, South Kensington, S.W.7.

(e) Chemical Laboratories, University *College, Gower Street, W.C.1.*

(f) Fuel Research Station, East Greenwich (limited to 50).

(g) Research Laboratories and Glass Works of the General Electric Company, Ltd., Wembley (limited to 40).

Evening.—Couversazione (to be arranged later).

FRIDAY, JULY 23.

Whole Day.—Excursion to Reading (limited to 160). The Works of Messrs. Huntley and Palmers, Ltd., will be visited, luncheon and tea being provided by the kindness of the Directors. The day's programme includes a trip on the Thames, and dinner will be taken at Skindles Hotel, Maidenhead, which will be reached by *charabanc via* Henley. It is especially requested that persons engaged in competitive industries will not apply for tickets for this excursion. Tickets (excluding wine at dinner) 15s. Times of trains will be announced later.

10.30 a.m.—Meeting in the Marylebone Room, Hotel Great Central, arranged by the Institution of Chemical Engineers and the Oil and Colour Chemists' Association, for discussion on "Fat Extraction by Solvents." A paper on this subject by Mr. L. J. Simon and Professor J. W. Hinchley will be read.

10.30 a.m.—Meeting of the Fuel Section in the Empire Room, Hotel Great Central. Chairman: Professor Arthur Smithells, F.R.S. *Summary of the Symposia at* Leeds and Sheffield on "Solid Smokeless Fuel," by Dr. E. W. Smith.

Afternoon.—Launch trip from Westminster to Greenwich, tea being served on the return journey. A visit will be made to East Ham for inspection of the new Fat Extraction Plant described at the morning meeting.

THE AMERICAN CHEMICAL SOCIETY.

GOLDEN JUBILEE.

The American Chemical Society was founded in 1876. It celebrates its fiftieth anniversary in Philadelphia, Pennsylvania, U.S.A., September 6 to 11, 1926. It is anticipated that some 3,500 chemists from all parts of the world will be present. The Society will meet in eighteen divisional gatherings, as follows:—

Agricultural and food chemistry; biological chemistry; cellulose chemistry; chemical education; dye chemistry; fertiliser chemistry; gas and fuel chemistry; industrial and engineering chemistry; leather and gelatin chemistry; medicinal products chemistry; organic chemistry; petroleum chemistry; physical and inorganic chemistry; rubber chemistry; sugar chemistry; water, sewage and sanitation chemistry; history of chemistry; paint and varnish chemistry.

Many of the divisions will hold special symposia of papers and addresses of importance from authorities in their respective fields. In addition, there will be two general meetings of the whole Society with evening entertainments and gatherings open to all members and visitors.

The American Chemical Society will send no direct invitations or requests for the appointment of special delegates from other organisations. Instead, it publicly invites all non-American chemists to attend and take part in the meeting on the same basis and under the same conditions as members of the Society.

The American Chemical Society is expecting many visiting chemists from other countries, and will endeavour to see that they are given warm welcome in full fellowship at this gathering. Foreign chemists expecting to attend the meeting should, if possible, send advance information to Charles L. Parsons, Secretary, Mills Building, Washington, D. C., U.S.A.

THE OPTICAL SOCIETY.

At a meeting of the Optical Society, held at the Imperial College of Science and Technology, South Kensington, on Thursday, June 10, 1926, the following papers were presented and discussed.

The Distribution of Light in Elementary Optical Images. By L. C. MARTIN, A.R.C.S., D.I.C., D.Sc.

The paper presents the results of a series of calculations on the distribution of light near the "star focus" of a centered lens system in the following cases: (a) freedom from aberration; (b) primary spherical aberration; (c) zonal spherical aberration. In the two latter cases the condition chosen is that when the least residual phase differences amount to $\pi/2$. The characteristic extra-focal effects are determined, and the effect of primary spherical aberration on resolving power is discussed. In the case of zonal aberration the greatest axial intensity is not found at the focus giving least phase residuals. In both cases of aberration a concentration closely resembling in some respects the "Airy" disc characteristic of zero aberration is found. These results are an extension of those previously obtained by Conrady and Buxton.

The Stationary Value of Axially Symmetric Functions. By T. SMITH, M.A., F.Inst.P.

The formula for the stationary value of a function is put into a form which shortens the calculations involved in applying it to functions which possess special kinds of symmetry, such as that corresponding to symmetry about an axis.

Note on the Criterion for the Best Position of Focus. By T. SMITH, M.A., F.Inst.P.

The position in which the amount of energy within the first dark ring of the diffraction image of a point is a maximum is suggested as not unlikely to correspond to the best focus found by visual observation in the presence of moderate amounts of aberration.

THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

APRIL—MAY EXAMINATIONS, 1926.

PASS LIST.

Examination for the Associateship in General Chemistry.—

Bond, Edward John, B.Sc. (Lond.), West Ham Municipal College; Bothamley, Richard Parkinson, B.Sc. (Lond.), University College, Nottingham; Bourne, Frank, The Technical College, Loughborough; Coucill, Joe Harrop, A.M.C.T., Manchester College of Technology; Elvidge, Wilfred Farrand, B.Sc. (Lond.), University College, Nottingham; Groves, Ida, Mary, B.Sc. (Birm.), The University, Birmingham; Henshaw, Charles Royston, A.M.C.T., Manchester College of Technology; Massie, Duncan McRobert, A.M.C.T., Royal Technical College, Salford, and Manchester College of Technology; Reid, Eric, Liverpool Central Technical School.

Examination for the Fellowship.

In Branch A: Inorganic Chemistry, Section II: Metallurgy.—Forrester, Charles.

In Branch B: Physical Chemistry.—Byrne, Laurence James Patrick, B.Sc. (Birm.); Herd, Clifford William, B.Sc. (Lond.).

In Branch E: The Chemistry (including Microscopy) of Foods and Drugs, and of Water. — Chalmers, Frederick Grant Duncan, M.A., B.Sc. (Aberd.); Fraser, James Ross, A.C.G.F.C., B.Sc. (Lond.); Hope, William Plenderleigh Lewellen, B.Sc. (Edin.); House, Cecil John, A.R.C.S., B.Sc. (Lond.); McKean, John Brown; Napier, Oswald James Walter, M.A. (Cantab.).

In Branch F: Biochemistry.—Boyd, Major Thomas Crawford, I.M.S., F.R.C.S., L.R.C.P. (Ireland), D.P.H.

NEW SECRETARY OF THE FARADAY SOCIETY.

Mr. G. S. W. Marlow, B.Sc., F.I.C., has been released by the Association of British Chemical Manufacturers to devote part of his time to the appointment of Secretary and Editor of the Faraday Society and Secretary of the Institute of Physics, pending the completion of final arrangements for carrying on the official work of these bodies. Mr. Marlow was Assistant Secretary to the Institute of Chemistry from 1919-1925.

FORTHCOMING EVENTS.

ROYAL SOCIETY OF ARTS.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One-hundred-and-seventy-second Annual General Meeting, for the purpose of receiving the Council's Report and the Financial Statement for 1925, and also for the election of Officers and new Fellows, will be held, in accordance with the By-laws, on Wednesday, June 30, at 4 p.m.

THE OPTICAL SOCIETY.

A Meeting of the Optical Society will be held at the Imperial College of Science, Imperial Institute Road, South Kensington, at 7.30 p.m., on Thursday June 24, 1926.

Communications.—A paper on "Joseph Fraunhofer and the Development of Optical Instruments," written by Professor M. von

Rohr to commemorate the centenary of the death of Fraunhofer, will be presented and discussed.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

12,642.—Appel, R.—Electrolytic separation of metallic chromium. May 17th.

12,682.—Imai, S., & Urano, S.—Manufacture of pure calcium hypochlorites. May 18th.

12,576.—New Jersey Zinc Co.—Treatment of zinc oxide. May 17th.

12,748.—Petroff, G.—Production of sulpho-aromatic fatty acids. May 18th.

12,681.—Urano, S., and Imai ,S.—Manufacture of basic calcium hypochlorites. May 18th.

Abstract Published.

252,039.—Fielding, W. R.—Fertilisers.

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Specifications Published.

249,978.—Catalytic oxidation of aromatic hydrocarbons. — Green, A. G., Quedgley, Hersham, Surrey.

Anthraquinone; phthalic acid and anhydride; catalytic apparatus.—In the catalytic oxidation of aromatic hydrocarbons in the vapour phase by means of an oxygen-containing gas, the surplus reaction heat is absorbed by the injection of water spray or mist into the spaces between successive catalyst zones; the water becomes vaporised by the hot gases, thereby reducing their temperature, and by adjustment of the amount of water introduced, the temperature conditions of the process can be controlled. The process is particularly applicable to the production of phthalic acid and anhydride from naphthalene and of anthraquinone from anthracene. The reaction chamber of metal such as iron, or refractory material such as brick, contains a number of superimposed perforated plates upon which is placed the catalytic material, which may be lumps of pumice coated with vanadium pentoxide. All metallic surfaces which come into contact with hot reaction gases are preferably coated with sodium silicate and asbestos powder. Spray producers or atomisers project into the spaces between the plates for the injection of water mist; the amount of water introduced is determined by the reading of the pyrometer projecting into the same space. A mixture of say naphthalene vapour and air, obtained by passing warm air through an insulated wooden chamber containing a number of perforated trays carrying naphthalene, is either passed directly through a heated pipe into the reaction chamber or is first preheated by means of the hot gases issuing from the chamber. The direction of the gases through the reaction chamber may be changed at intervals. The issuing gases are led into a series of empty vessels for condensation of the product, after first passing, if desired through the preheater for the ingoing gases.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25 ,Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

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MILOID.

467,956.—A fuel economising composition, being a chemical substance.—Grimsby Wholesale Chemical Co., Ltd., 17, Chantry Lane, Grimsby. June 2nd.

SORBSIL.

468,286.—Chemical substances used in manufactures, photography, or philosophical research and anti-corrosives.—J. Crosfield & Sons, Ltd., Bank Quay Warrington, Lancashire. June 2nd.

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